MARYLAND BIOLOGICAL STREAM SURVEY
2000-2004

VOLUME IV
ECOLOGICAL ASSESSMENT OF WATERSHEDS SAMPLED IN 2003

CHESAPEAKE BAY AND
WATERSHED PROGRAMS
MONITORING AND
NON-TIDAL ASSESSMENT
CBWP-MANTA-EA-05-1

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Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401

Toll free in Maryland: 1-(877)- 620-8DNR ext. 8610
Out of state call: 410-260-8610
TTY via Maryland Relay: 711 (within MD)
800-735-2258 (out of state)
www.dnr.maryland.gov

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MARYLAND BIOLOGICAL STREAM SURVEY 2000-2004

Volume IV: Ecological Assessment of Watersheds Sampled in 2003

Prepared for

Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, MD 21401

Prepared by

Nancy E. Roth
Mark T. Southerland
Ginny M. Rogers
Jon H. Vølstad

Versar, Inc.
9200 Rumsey Road
Columbia, MD 21045

January 2005

FOREWORD

This report, *Maryland Biological Stream Survey 2000-2004, Volume IV: Ecological Assessment of Watersheds Sampled in 2003,* supports the Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS) under the direction of Dr. Ronald Klauda and Mr. Paul Kazyak of the Monitoring and Non-tidal Assessment Division. Versar's work and this report were prepared under Maryland's Power Plant Research Program (Contracts No. PR-96-055-001 and K00B0200109 to Versar, Inc.). A major goal of the MBSS is to assess the ecological condition of Maryland's streams, with a particular focus on biological resources, but also evaluate water chemistry and physical habitat. Round Two of the MBSS was designed to characterize and assess watersheds over a five year cycle (2000-2004). This annual report presents results from watersheds sampled in 2003. This report includes a history of the program, a description of methods and survey design, comparative assessments by watershed, detailed results for individual watersheds, and comparisons with Round One results (from 1995-1997).

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ACKNOWLEDGMENTS

The 2003 MBSS has been a cooperative effort among several agencies and consultants. We at Versar wish to thank Ronald Klauda and Paul Kazyak from the Maryland Department of Natural Resources (DNR) for directing the program and supporting Versar in preparing this report. DNR and the University of Maryland's Appalachian Laboratory (AL) each provided field crews and did a great job collecting the data. DNR digitized watersheds and calculated land use data, provided quality assurance, conducted crew training, and performed field sampling. Tony Prochaska of DNR contributed to writing this report. Mark Southerland and Paul Kazyak served as its editors. Dr. Ray Morgan of the University of Maryland’s Appalachian Laboratory supervised one field crew and oversaw water chemistry laboratory analysis. Dr. Rich Raesly of Frostburg State University provided taxonomic verifications of voucher fish specimens. Versar designed the sampling program, obtained landowners’ permissions, conducted statistical analyses, and prepared this report.

The success of the project resulted from the strong efforts of all these groups. We particularly thank the key individuals listed below for their contributions:

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Alan Heft
David Kazyak
Kenny Mack
Danielle Kazyak
Matt Rifey
Andrew Decker
Theresa RaFigue
Marcia Snyder

Data management was conducted jointly by Marty Hurd of Maryland DNR and Ginny Rogers of Versar, Inc.

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ABSTRACT

This report presents the results of sampling conducted in 2003 by the Maryland Biological Stream Survey (MBSS or the Survey) to assess the "state of the streams" throughout Maryland. The year 2003 was the fourth of five years of sampling planned for the second round of the Survey. Results for each year of Round Two will be reported annually and additional summary volumes will be published when Round Two sampling is completed in 2004.

MBSS 2003 Results. In 2003, the Survey continued to provide invaluable information on the abundance and distribution of rare species to support a more thorough understanding of Maryland's biodiversity. During MBSS sampling in 2003, a number of occurrences of rare fish were documented, including two state-listed rare species: flier and pearl dace.

The status of sampled watersheds and individual stream segments was assessed, focusing on the condition ratings of the fish and benthic Indices of Biotic Integrity (IBI), indicators previously developed by the Survey and employed in evaluating Round One (1995-1997) results. IBI scores for each site were determined by comparing the fish or benthic assemblage to those found at minimally disturbed reference sites.

Fish IBI scores at sites sampled in the 2003 MBSS spanned the full range of biological condition, from 1.0 (very poor) to 4.56 (good). Mean fish IBI per PSU (one or more 8-digit watersheds) ranged from 1.21 (Georges Creek) to 3.88 (Lower Elk River PSU).

Benthic macroinvertebrate IBI scores spanned the range of biological conditions from 1.0 (very poor) to 5.0 (good). The lowest mean benthic IBI was 1.71 in the Pocomoke Sound PSU. The highest mean benthic IBI was 3.73 in Potomac River Lower North Branch. Within-PSU variability ranged from low to high.

In 2003, estimates of the percentage of stream miles sensitive to acidification (i.e., those with ANC < 200 μeq/l) followed the geographic pattern noted in the Maryland Synopic Stream Chemistry Survey (MSSCS) of 1987 and Round One MBSS, with the greatest extent of acid-sensitive streams observed in Western Maryland and the Southern Coastal Plain. Nine PSUs, primarily in the same regions, had sites highly sensitive to acidification (ANC < 50 μeq/l). Also paralleling the Round One results, acidic deposition effects (42 sites in 14 PSUs) were more widespread than effects from acid mine drainage (0 sites) or agriculture (11 sites in 2 PSUs).

A revised Physical Habitat Index (PHI), was developed using earlier MBSS data through 2000 (Paul et al. 2003) was used to score sites sampled in 2003. PHI scores varied widely within and among PSUs. No PSUs had PHI mean scores indicating severe degradation and only one PSU (Potomac River Lower North Branch) had a mean PHI score indicating minimal degradation. Stream mile estimates of the occurrence of poor to very poor PHI scores suggest that physical habitat degradation is widespread.

MBSS 2003 results indicate that stream channelization is common in some Maryland watersheds, particularly in the Coastal Plain. Moderate to severe bank erosion also occurs commonly in Maryland streams. Bank erosion contributes to sediment-related impacts locally, in tidal rivers downstream, and ultimately in the Chesapeake Bay. Mean values by PSU were used to estimate the extent of eroded area (square meters) per stream mile. Highest values were in the Lower Monocacy River, Liberty Reservoir, and Rock Creek/Cabin John Creek PSUs. The combined area of eroded bank in all 19 PSUs sampled in 2003 totaled more than 510 acres. Exacerbated bar formation was observed in most watersheds sampled in 2003. Lack of riparian vegetation on at least one stream bank was observed within 11 of 19 PSUs. Exotic plants, such as multiflora rose, mile-a-minute, and Japanese honeysuckle were present along stream sites in most watersheds. The total number of instream pieces of woody debris and rootwads was highest in the Port Tobacco and St. Mary's River PSUs.

In Maryland, concern for nutrient loadings to the Chesapeake Bay has drawn attention to the amounts of nitrogen and phosphorus transported throughout the watershed by streams. In MBSS 2003 sampling, total nitrogen tended to be highest on the Eastern Shore. In general, nitrate nitrogen made up the largest fraction of total nitrogen. Nitrate nitrogen concentrations greater than 1 mg/l are commonly considered to indicate anthropogenic influence; mean nitrate nitrogen concentrations exceeded this level in 12 of 19 PSUs. In several PSUs, nearly 100% of stream miles had high nitrate nitrogen concentrations. Total phosphorus tended to be substantially higher on the Eastern Shore, lower in Western Maryland, and moderate in the central part of the state.

Management Implications and Future Directions. The information being obtained by Round Two of the MBSS will continue to support a wide array of management decisions by Maryland DNR and other agencies. Major initiatives that have or will benefit from MBSS data include the new 2000 Chesapeake Bay Agreement, Maryland Land Conservation, Clean Water Action Plan, State water quality standards, Maryland biodiversity, and local monitoring programs.

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EXECUTIVE SUMMARY

This report presents the results of sampling conducted in 2003 by the Maryland Biological Stream Survey (MBSS or the Survey) to assess the "state of the streams" throughout Maryland. The year 2003 was the fourth of five years of sampling planned for the second round of the Survey. Results for each year of Round Two will be reported annually and several summary volumes will be published when Round Two sampling is completed.

Background. Supported and led by the Maryland Department of Natural Resources (DNR), the MBSS is a comprehensive program to assess the status of biological resources in Maryland's non-tidal streams; quantify the extent to which acidic deposition affects critical biological resources in the state; examine which other water chemistry, physical habitat, and land use factors are important in explaining stream conditions; provide a statewide inventory of stream biota; establish a benchmark for long-term monitoring; and target future local-scale assessments and mitigation measures needed to restore degraded biological resources. To meet these and other objectives, the Survey has established a list of questions of interest to environmental decision makers that guide its design, implementation, and analysis. These questions fall into three categories: (1) characterizing biological resources and ecological conditions (such as the number of stream miles with pH < 5), (2) assessing their condition, and (3) identifying likely sources of degradation.

To answer these questions, a number of steps have been taken since the Survey's inception, including (1) devising a sampling design, (2) field testing sampling protocols and logistics to assure data quality and precision, (3) conducting an extensive, multi-year field sampling program, (4) developing reference-based indicators of biological integrity, and (5) using analytical methods to evaluate contributions of different anthropogenic stresses, including land use. Sampling is probability-based (i.e., randomized), allowing accurate and robust population estimates of variables and sampling variance, so that estimates of status can be made with quantifiable confidence. In addition, the Survey focuses on biological responses to stress, but also collects data to characterize pollutant stress and habitat condition. Third, its scale is watershed-wide and statewide, rather than local.

MBSS Round Two Design. 2003 was the fourth year of sampling for Round Two of the Survey. Round Two includes both (1) a core survey based on statewide sampling of random stream segments and (2) ancillary sampling dedicated to additional monitoring and special studies. The core survey produces the majority of MBSS results and is the focus of this report. Some information gathered by the ancillary sampling is included, but extensive data analysis of these additional results is reserved for separate reports.

To meet the State's growing need for information at finer spatial scales, Round Two's core survey was redesigned to focus on Maryland's 8-digit watersheds (averaging 75 mi^2 in area) rather than drainage basins (averaging 500 mi^2). The Round Two design is based on first- through fourth-order, non-tidal streams on a new 1:100,000-scale base map. The study design allows estimates at the level of 84 individual or combined Maryland 8-digit watersheds that serve as primary sampling units (PSUs). Each PSU has 10 or more sample sites. To achieve this sample density while sampling approximately 210 sites each year, Round Two will take five years to complete, running from 2000 through 2004 (rather than the three years in Round One, 1995-1997).

The MBSS uses a probability-based survey design called lattice sampling to schedule sampling statewide over a multi-year period. The lattice design of Round Two stratifies by year and PSU, and restricts the sampling each year to about one-fifth of the state's 138 watersheds. Approximately 300 stream segments (210 in the core survey) of fixed length (75 m) are sampled each year, with biological, chemical, and physical parameters measured at each segment using standardized methods. Biological measurements include the abundance, size, and individual health of fish; taxa composition of benthic macroinvertebrates; and presence of amphibians, reptiles, mussels, and aquatic vegetation. Chemical analytes include pH, acid-neutralizing capacity (ANC), nitrogen, phosphorus, sulfate, chloride, conductivity, dissolved oxygen (DO), and dissolved organic carbon (DOC). Physical habitat parameters include commonly used observational measurements such as instream habitat structure, embeddedness, pool and riffle quality, shading, and riparian vegetation, as well as quantitative measurements such as stream gradient, maximum depth, wetted width, and discharge. Channelization, bank erosion, bar formation, and land use immediately visible from the segment are assessed. Additional land use data for the entire catchment upstream of each sample site are incorporated from statewide geographic information system (GIS) coverages.

For the most part, methods used in Round Two are identical to those of Round One. However, some changes were made to improve the quality and/or usefulness of the data generated. These changes in sampling methods include (1) modifications to habitat assessment and characterization, (2) the addition of new chemical analytes (total dissolved nitrogen, total particulate nitrogen, nitrite nitrogen, ammonia, ortho-phosphate, total dissolved phosphorus, total particulate phosphorus, chloride, and turbidity), (3) collection of continuous temperature readings in the summer, (4) characterization of invasive plant abundance, and (5) the addition of altitude as a physical variable. In addition, the reach file used to select sites is the USGS 1:100,000-scale map; this is a change from the 1:250,000-scale map used in Round One, meaning that more small streams will be sampled in Round Two. Another change to the sample frame is the inclusion of fourth-order streams.

Although the Survey will provide the data needed to characterize the status of all 8-digit watersheds, it will not have sufficient sampling density to characterize most of the 1066 12-digit subwatersheds. Therefore, Round Two of the MBSS has been expanded to include coordination with volunteer efforts (such as DNR's Maryland Stream Waders) and County stream monitoring programs. Ultimately, by incorporating these data, the MBSS hopes to better characterize many areas of the state at this finer spatial scale.

In addition to improving the spatial intensity of sampling, Round Two will address temporal variability by regular monitoring of fixed "sentinel" sites. In 2000, DNR established a network of approximately 25 sentinel sites deemed to be minimally impacted by human activities, in areas where land uses were unlikely to change over time (e.g., state parklands). With some modifications, these sites were again sampled in 2003, and will continue to be sampled throughout Round Two.

In 2003, 19 PSU's containing 219 sites were sampled. Ancillary sampling was conducted in 2003 to support the National Park Service at sites in the Chesapeake and Ohio Canal. Additional sites were also sampled in Lower Gunpower Falls as part of a study on Minebank Run.

MBSS 2003 Results. In 2003, the Survey continued to provide invaluable information on the abundance and distribution of rare species to support a more thorough understanding of Maryland's biodiversity. During MBSS sampling in 2003, a number of occurrences of rare fish were documented, including two state-listed rare species: flier and pearl dace.

The status of sampled watersheds and individual stream segments was assessed, focusing on the condition ratings of the fish and benthic Indices of Biotic Integrity (IBI), indicators previously developed by the Survey and employed in evaluating Round One results. IBI scores for each site were determined by comparing the fish or benthic assemblage to those found at minimally disturbed reference sites.

IBI data for each PSU are depicted in box-and-whisker plots and mean IBIs for PSUs sampled in 2003 were mapped. Over the next year of Round Two sampling, data will be collected in remaining PSUs to complete an updated statewide picture of biological conditions. Data were also used to estimate the extent of streams in poor to very poor condition (IBI < 3) within each PSU. The MBSS Round Two study design, based on simple random sampling, makes it possible to calculate an exact confidence interval around each estimate based on the binomial distribution. The extent of streams within a given condition (e.g., IBI < 3) is expressed as a percentage of all first- through fourth-order stream miles in the PSU, with an associated 90% confidence interval around the estimate.

The indicators used were developed during Round One of the MBSS and have been deemed reliable for representing ecological condition by field verification and expert peer review. Nonetheless, the Survey continues to pursue refinements to its indicators including improvements to the provisional physical habitat index (PHI), methods for combining indicators that do not lose information (e.g., combined biotic index), and changes to the indicator thresholds and scoring methods to make them more intuitive and accessible to the public.

Fish IBI scores at sites sampled in the 2003 MBSS spanned the full range of biological condition, from 1.0 (very poor) to 4.56 (good). Mean fish IBI per PSU ranged from 1.21 (Georges Creek) to 3.88 (Lower Elk River PSU). The greatest extent of occurrence of streams with fish IBI < 3 (expressed as 90% confidence intervals) was in Georges Creek (59 to 100% of stream miles).

Benthic macroinvertebrate IBI scores spanned the range of biological conditions from 1.0 (very poor) to 5.0 (good). The lowest mean benthic IBI was 1.71 in the Pocomoke Sound PSU. The highest mean benthic IBI was 3.73 in Potomac River Lower North Branch. Within-PSU variability ranged from low to high. The greatest extent of occurrence of streams with benthic IBI < 3 (expressed as 90% confidence intervals) was in the Pocomoke Sound PSU (56 to 100% of stream miles).

To integrate the results of fish and benthic IBI assessments, a Combined Biotic Index (CBI) was calculated as the mean of the fish and benthic IBI values at a site. If only one score was available (e.g., benthic IBI but no fish IBI), the single score was assigned as the CBI. CBI scores from core MBSS sites ranged from 1.00 (very poor) to 5.0 (good). Mean CBI per PSU ranged from 1.84 (Pocomoke Sound PSU) to 3.39 (Broad Creek), paralleling the benthic IBI results.

The effects of acidic deposition and acid mine drainage (AMD) on stream chemistry are well documented. Round One MBSS results (Roth et al. 1999) and an assessment of these results in comparison with critical loads (Miller et al. 1998) confirmed that stream acidification continued to be a problem in Maryland freshwater streams. In 2003, estimates of the percentage of stream miles sensitive to acidification (i.e., those with ANC < 200 μeq/l) followed the geographic pattern noted in the Maryland Synopic Stream Chemistry Survey (MSSCS) of 1987 and Round One MBSS, with the greatest extent of acid-sensitive streams in Western Maryland and the Southern Coastal Plain. Nine PSUs, primarily in the same regions, had sites highly sensitive to acidification (ANC < 50 μeq/l). Also paralleling the Round One results, acidic deposition effects (42 sites in 14 PSUs) from acid mine drainage (0 sites) or agriculture (11 sites in 2 PSUs).

Although many water resource programs tend to focus on water chemistry-based definitions of stream quality, physical habitat degradation can have an equal or greater effect on stream ecosystems and their biological communities. A revised Physical Habitat Index (PHI), developed using MBSS data through 2000 (Paul et al. 2003) was used to score sites sampled in 2003. PHI scores varied widely within and among PSUs. No PSUs had PHI mean scores indicating severe degradation and only one PSU (Potomac River Lower North Branch) had a mean PHI score indicating minimal degradation. Stream mile estimates of the occurrence of poor to very poor PHI scores suggest that physical habitat degradation is widespread.

MBSS 2003 results indicate that stream channelization is common in some Maryland watersheds, particularly in the Coastal Plain. Moderate to severe bank erosion also occurs commonly in Maryland streams. Bank erosion contributes to sediment-related impacts locally, in tidal rivers downstream and ultimately in the Chesapeake Bay. Mean values by PSU were used to estimate the extent of eroded area (square meters) per stream mile. Highest values were in the Lower Monocacy River, Liberty Reservoir, and Rock Creek/Cabin John Creek PSUs. The combined area of eroded bank in all 19 PSUs totaled more than 510 acres. Exacerbated bar formation was observed in most watersheds sampled in 2003. Lack of riparian vegetation on at least one stream bank was observed within 11 of 19 PSUs. Exotic plants, such as multiflora rose, mile-a-minute, and Japanese honeysuckle was present along stream sites in most watersheds. The total number of instream pieces of woody debris and rootwads was highest in the Port Tobacco and St. Mary's River PSUs.

During 2003, MBSS deployed continuous reading water temperature loggers at more than 200 sites between the months of June and August. The long-term goal is to use temperature data to (1) better characterize coldwater streams and (2) identify streams stressed by temperature changes, such as spikes from rapid inputs of warm water running off impervious surfaces during summer storms. Among all sites assessed, mean average daily water temperatures ranged from 14.8 to 28.5 °C, indicating the presence of both coldwater and warmwater sites in the data set. Future analyses of data from coldwater streams will assist in interpretation of IBI scores and will contribute to development of a fish IBI tailored to these systems, because trout and several non-game species require cool to cold waters.

In Maryland, concern for nutrient loadings to the Chesapeake Bay has drawn attention to the amounts of nitrogen and phosphorus transported throughout the watershed by streams. In MBSS 2003 sampling, total nitrogen tended to be highest on the Eastern Shore. In general, nitrate nitrogen made up the largest fraction of total nitrogen. Nitrate nitrogen concentrations greater than 1 mg/l are commonly considered to indicate anthropogenic influence; mean nitrate nitrogen concentrations exceeded this level in 12 of 19 PSUs. In several PSUs, nearly 100% of stream miles had high nitrate nitrogen concentrations. Total phosphorus tended to be substantially higher on the Eastern Shore, lower in Western Maryland, and moderate in the central part of the state.

Dissolved oxygen (DO) concentrations at most locations were greater than 5 mg/l, the COMAR standard and a level generally considered healthy for aquatic life. Two PSUs had a mean DO < 5 mg/l: the Honga River PSU and the Pocomoke Sound PSU. Because sampling is done when the water is fairly clear, turbidity was generally low; a more complete characterization of turbidity would require sampling during storm events. Sulfate values were not generally high. Chloride tended to be highest in urban areas, especially in Central Maryland, and also at several sites near roadways that probably received substantial amounts of road salt. As expected, mean DOC and particulate carbon were highest in Coastal Plain basins, especially on the Eastern Shore.

Since the primary focus of the Round Two Survey is on smaller watersheds than in Round One, more attention has been paid to examining sampling results and potential stressors at individual sites. This report includes a snapshot of good and bad conditions that is illustrated by sites with the 10 best and 10 worst CBI scores in 2003.

The report also includes a summary of results for each of the 19 PSUs sampled in the core (random) sampling for MBSS 2003. Each summary includes maps, land use statistics, and tables containing a variety of information on the sites sampled in each PSU. The benthic macroinvertebrate assessment results for the sites sampled by the volunteer Stream Waders program in 2003 are also indicated on each map.

As each round of statewide sampling by the Survey is conducted at regular intervals over time, temporal changes (trends) in the stream condition statewide or for individual 8-digit watersheds can be evaluated. A comparison with statewide data from Round One (1995-1997) was conducted and the percentage of stream miles in each category of IBI score remain relatively stable over time.

In 2000, the Survey initiated an annual monitoring effort at minimally disturbed sites (referred to as Sentinel sites) to help interpret the degree to which changes in biological indicator scores stem from natural variability. Sentinel sites are high quality sites most likely to remain undisturbed in the foreseeable future within four geographic regions of Maryland. In 2003, 26 sites were sampled. Although no more than four years of sampling is now available for any site, comparison of CBIs indicated that approximately 54% of all Sentinel sites varied less than 1.0. This percentage is much lower than in previous years, perhaps indicating an effect of draught conditions.

Management Implications and Future Directions. The information being obtained by Round Two of the MBSS will continue to support a wide array of management decisions by Maryland DNR and other agencies. Major initiatives that have or will benefit from MBSS data include the new 2000 Chesapeake Bay Agreement, Maryland Land Conservation, Clean Water Action Plan, State water quality standards, Maryland biodiversity, and other local monitoring programs.

The MBSS results are expected to be highly useful for the new stream corridor commitments of the Chesapeake Bay Program. The Chesapeake 2000 Agreement (signed by Virginia, Maryland, Pennsylvania, District of Columbia, U.S. Environmental Protection Agency (EPA), and Chesapeake Bay Commission) newly recognizes “the need to focus on the individuality of each river, stream and creek” to meet the goal—“Preserve, protect and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Bay and its rivers.” The stream corridor information provided by the Survey will also prove invaluable for other statewide programs. As part of the Chesapeake Bay-wide goal of restoring 2,010 miles of riparian buffers in the Chesapeake Bay watershed by the year 2010, Maryland is restoring 1200 miles of riparian vegetation along its stream corridors. MBSS data on the condition of constituent streams will help assign priorities for the purchase of GreenPrint and Rural Legacy lands.

The results of Round Two will continue to support Maryland’s participation in the federal Clean Water Action Plan. Round One MBSS data were an essential component of the first Unified Watershed Assessment, helping designate both Category 1 (priorities for restoration) and Category 3 (priorities for protection) watersheds within Maryland. Restoration strategies have been developed by DNR and several county agencies for many of these priority watersheds, and 2003 sampling results will be used to help implement them (e.g., in Little Patuxent River watershed). Because the design of Round Two focuses on the finer geographic scale of Maryland 8-digit watersheds, future Unified Watershed Assessments in Maryland will be more complete.

In addition to supporting these targeting initiatives, the identification of degraded stream segments has implications for comprehensive protection under the Clean Water Act, including use of MBSS 2002 (along with other data) to prepare the State’s Clean Water Act 303(d) list and biennial 305(b) water quality report. In particular, the Maryland Department of the Environment has developed an interim framework for the application of biocriteria in the State’s water quality standards and list of impaired waters (303(d) list). At present, the proposed biocriteria for wadeable, non-tidal (first- to fourth-order) streams rely on two biological indicators from the MBSS, the fish and benthic IBIs. The approach centers on identifying impaired waterbodies at the Maryland 8-digit watershed and 12-digit subwatershed levels. Ultimately these MBSS biological data may also contribute to refinement of the States’ aquatic life use designations.

The information on biological diversity collected by the Survey exceeds that needed to designate the ecological condition of individual watersheds. The extensive geographic reach and quantitative sampling results of the Survey provide an unusual opportunity for evaluating the distribution and abundance of species previously designated as rare only by anecdotal evidence. For example, the endemic checkered sculpin and several other species have been collected in previously unreported locations. Based on the information gathered in Round One, Maryland DNR’s Heritage and Biodiversity Programs recently proposed changes to state designations of rare, threatened, and endangered species.

One of the most promising trends related to the Survey has been the increase in interest and activity among Maryland county governments, non-governmental organizations, private businesses, and volunteers in stream monitoring. The success of the Survey has encouraged these groups to base their water resource management more directly on monitoring results. Many have instituted their own monitoring programs, often drawing upon or adopting MBSS sampling protocols. This report highlights the improved watershed coverage that can be obtained by incorporating volunteer Stream Waders data and the increased precision in stream assessments that can be attained by integrating MBSS data with that from local government monitoring programs such as Montgomery County. Maryland DNR expects to continue integration of the MBSS with those local government agencies that already have or are planning to initiate their own stream monitoring programs. The Maryland Water Monitoring Council (MWMC) will play an active role in encouraging collaborations between the state and local agencies.

As described above, the Round Two design provides significantly improved geographic resolution and additional stressor data, although more comprehensive understanding of watershed stressors will require data from other sources. Issues that require continued scrutiny in future years include the following:

- Extending the Survey into tidal streams
- Delineating more stream types requiring new indicators (e.g., coldwater and blackwater streams)
- Refining existing biological and physical habitat indicators
- Better characterization of existing and new stressors (e.g., estimating the contribution of eroded soil to sediment loading)
- Improving identification of rare species habitats and other biodiversity components
- Comparing among sample rounds for the detection of trends in stream conditions
- More coordination with counties for greater sample density or cost savings in areas of shared interest

In 2003, the Survey continued to make progress toward addressing these issues. Specifically, temperature loggers were deployed at nearly all randomly selected stream sites in 2000-2003 (and will continue to be deployed throughout Round Two) to improve our ability to identify coldwater streams. Analysis of existing coldwater and blackwater stream data was begun in hopes of developing separate reference conditions, and ultimately separate indicators, for these stream types.

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1 INTRODUCTION

This report presents the results of the fourth year of the second round of sampling conducted by the Maryland Biological Stream Survey (MBSS or the Survey) to assess the Astate of the streams@ throughout Maryland. The year 2003 was the fourth of five years of sampling planned for Round Two. Sampling for the three-year Round One of the Survey was completed in 1997 and was summarized in Roth et al. (1999) and Boward et al. (1999). Results for each year of Round Two are reported annually and a summary report will be published when Round Two sampling is completed (for 2000 through 2002 results, see Roth et al. 2001b , Roth et al. 2003, Roth et al. 2004). This introductory chapter describes the history of the Survey, describes its components, and provides a roadmap to this year 2003 annual report.

1.1 HISTORY OF THE MBSS

In the 1980s, the Maryland Department of Natural Resources (DNR) recognized that atmospheric deposition was one of the most important environmental problems resulting from the generation of electric power. The link between acidification of surface waters and acidic deposition resulting from pollutant emissions was well established and many studies pointed to adverse biological effects of low pH and acid neutralizing capacity (ANC) and elevated levels of inorganic aluminum. To determine the extent of acidification of Maryland streams resulting from acidic deposition, DNR conducted the Maryland Synoptic Stream Chemistry Survey (MSSCS) in 1987. The MSSCS estimated the number of streams affected by or sensitive to acidification statewide, concluding that the greatest concentration of fish resources at risk may be in streams throughout the Appalachian Plateau and Southern Coastal Plain physiographic provinces (Knapp et al. 1988).

While the MSSCS demonstrated the potential for adverse effects on biota from acidification, little direct information was available from the field on the biological responses of Maryland streams to water chemistry conditions. For this reason, in 1993, DNR created the MBSS to provide comprehensive information on the status of biological resources in Maryland streams and how they are affected by acidic deposition and other cumulative effects of anthropogenic stresses. The MBSS is now eleven years old and continues to help environmental decision-makers protect and restore the natural resources of Maryland. The primary objectives of the MBSS are to

- assess the current status of biological resources in Maryland's non-tidal streams;
- quantify the extent to which acidic deposition has affected or may be affecting biological resources in the state;
- examine which other water chemistry, physical habitat, and land use factors are important in explaining the current condition of streams;
- provide a statewide inventory of stream biota;
- establish a benchmark for long-term monitoring of trends in these biological resources; and
- target future local-scale assessments and mitigation measures needed to restore degraded biological resources.

To meet these and other objectives of the MBSS, a list of 64 questions that the Survey will try to answer was developed. These questions fall into three categories: (1) characterizing biological resources, physical habitat, and water quality (such as the number of fish in a watershed or the number of stream miles with pH < 5); (2) assessing the condition of these resources (as deviation from minimally impaired expectations); and (3) identifying likely sources of degradation (by delineating relationships between biological conditions and anthropogenic stresses).

Answering these questions has required a progression of steps in the implementation of the Survey, including (1) devising a sampling design to monitor wadeable, non-tidal streams throughout the state and allow area-wide estimates of the extent of the biological resources, (2) implementing sampling protocols and quality assurance/quality control procedures to assure data quality and precision, (3) developing indicators of biological condition so that degradation can be evaluated as a deviation from reference expectations, and (4) using a variety of analytical methods to evaluate the relative contributions of different anthropogenic stresses.

In creating the Survey, DNR implemented a probability-based sampling design as a cost-effective way to characterize statewide stream resources. By randomly selecting sites, the Survey can make quantitative inferences about the characteristics of the more than 12,000 miles of non-tidal streams in Maryland. The EPA is encouraging the use of random sampling designs to assess status and trends in surface water quality (EPA 1993). The Round One MBSS design began with the MSSCS sample frame and was modified during the 1993 pilot and 1994 demonstration phases to provide answers to the questions of greatest interest (Vølstad et al. 1995, 1996). That design allowed robust estimates at the level of stream size (Strahler orders 1, 2, and 3), large watershed (17 river basins), and the entire state. Estimates by other categories, such as counties or smaller watersheds (138 in Maryland), were possible depending on the number of sample points in each unit. Round Two of the MBSS has a slightly different design that allows estimates at the level of smaller watersheds (85 individual or combined Maryland 8-digit watersheds); to achieve the necessary sample density at the available level of effort, Round Two will take five years to complete (rather than the three years in Round One).

DNR recognized that the utility of these estimates depended on accurately measuring appropriate attributes of streams. The Survey focuses on biology for two reasons: (1) organisms themselves have direct societal value and (2) biological communities integrate stresses over time and are a valuable and cost-effective means of assessing ecological integrity (i.e., the capacity of a resource to sustain its inherent potential). Inevitably, overall environmental degradation is tied to a failure of the system to support biological processes at a desired level (Karr 1993). It is equally important to recognize that the natural variability in biota requires that several components of the biological system be monitored. Fish are an important component of stream integrity and one that also contributes substantial recreational values. The Survey collects quantitative data for the calculation of population estimates for individual fish species (both game and nongame). These data can also be used to evaluate fish community composition, individual fish health, and the geographic distribution of commercially important, rare, or non-indigenous fish species. Benthic (bottom-dwelling) macroinvertebrates are another essential component of streams and they constitute the second principal focus of the Survey. The Survey uses rapid bioassessment procedures for collecting benthic macroinvertebrates; these semi-quantitative methods permit comparisons of relative abundance and community composition, and have proven to be an effective way of assessing biological integrity in streams (Hilsenhoff 1987, Lenat 1988, Plafkin et al. 1989, Kerans and Karr 1994, Resh 1995, Barbour et al. 1999). The Survey also records the presence of amphibians and reptiles (herpetofauna), freshwater mussels, and aquatic plants (both submerged aquatic vegetation (SAV) and emergent macrophytes). The Survey has established rigorous protocols (Kazyak 2001) for each of these sampling components, as well as training and auditing procedures to assure that data quality objectives are met.

Although the MBSS sampling design and protocols provide exceptional information for characterizing the stream resources in Maryland, designation of degraded areas and identification of likely stresses requires additional activities. Assessing the condition of biological resources (whether they are degraded or undegraded) requires the development of ecological indicators that permit the comparison of sampled segment results to minimally impacted reference conditions (i.e., the biological community expected in watersheds with little or no human-induced impacts). The Survey has used its growing database of information collected with consistent methods and broad coverage across the state to develop and test indicators of individual biological components (i.e., fish and benthic macroinvertebrates) and a provisional indicator of physical habitat quality (Roth et al. 2000, Stribling et al. 1998, Hall et al. 1999). These three indices are the basis for estimating the number of stream miles in varying degrees of degradation (good, fair, poor, and very poor condition) and mapping the locations of sites by their condition. Each of these indicators consists of multiple metrics using the general approach developed for the Index of Biotic Integrity (IBI) (Karr et al. 1986, Karr 1991) and the Chesapeake Bay Benthic Restoration Goals (Ranasinghe et al. 1994). The fish and benthic IBIs (which combine attributes of both the number and the type of species found) are widely accepted indicators that have been adapted for use in a variety of geographic locations (Miller et al. 1988, Cairns and Pratt 1993, Simon 1999). The Survey currently reports a composite fish and benthic indicator (Combined Biotic Index, or CBI) and is investigating the possibility of developing additional indicators (e.g., salamanders in small streams with few or no fish).

In addition to using reference-based indicators, the Survey applies a variety of analytical methods to the question of which stresses are most closely associated with degraded streams. This involves correlational and multivariate analyses of water chemistry, physical habitat, land use, and biological information (e.g., presence of non-native species). The biological information also provides an unusual opportunity for evaluating the status of biodiversity across the state; the distribution and abundance of species previously designated as rare only by anecdotal evidence can be determined and unique combinations of species at the ecosystem and landscape levels can be identified. Land use and other landscape-scale metrics also play an important role in identifying the relative contributions of different stresses to the cumulative impact on stream resources.

Ultimately, the Survey seeks to provide an integrated assessment of the problems facing Maryland streams that will facilitate interdisciplinary solutions.

The research progress and assessment results of Round One of the MBSS are reported in Roth et al. (1999) and Boward et al. (1999). Among other findings, Round One collected 83 fish species, including a number of rare species. According to the fish IBI, 45% of stream miles fell into the range of good to fair, while 49% fell into this range according to the benthic IBI. Similarly, 49% of stream miles were rated good to fair by the physical habitat index. Statewide, 28% of stream miles were acidic or acid sensitive, indicating a slight improvement since the 1987 MSSCS. Acidic deposition was by far the most common source of stream acidification, dominating 19% of stream miles. Statewide, 59% of stream miles had nitrate-nitrogen concentration greater than 1.0 mg/l, indicating anthropogenic sources. Nearly all sites with greater than 50% urban land use had IBI scores indicative of poor to very poor biological condition. These and other results are already being used by Maryland DNR to target resource management efforts and to reevaluate state designations of rare, threatened, and endangered species. MBSS Round One Results have also been used to support Maryland=s Unified Watershed Assessment and other components of the Federal Clean Water Action Plan, the Maryland Tributary Strategy Teams= plans to reduce nutrient contributions to the Chesapeake Bay, and the Maryland Department of the Environment=s water quality standards program that lists impaired waters and develops total maximum daily loads (TMDLs). Round Two of the Survey will continue to contribute to these activities and, by refining the assessment of watershed conditions, may provide even greater utility to managers.

1.2 ROUND TWO OF THE MBSS

2000 was the first year of sampling for Round Two of the Survey. Results from 2000-2002 can be found in Roth et al. (2001b), Roth et al. (2003), and Roth et al. (2004). Round Two is a natural extension of the MBSS as it began in 1993 and it includes both (1) a core survey based on statewide sampling of random stream segments and (2) ancillary targeted sampling dedicated to additional monitoring and special studies. The core survey produces the majority of MBSS results and is the focus of this report. The information gathered by the ancillary sampling is included where convenient for completeness, but extensive data analysis of these additional results is reserved for separate reports (but see Chapter 6 on Sentinel Site sampling).

To meet the state=s growing need for information at finer spatial scales, Round Two=s core survey was redesigned to focus on Maryland=s 8-digit watersheds (Table 1-1). The Round Two design was also based on a new 1:100,000-scale base map; this means that more small streams will be sampled than were sampled in Round One. Specifically, Round Two=s design allows estimates at the level of 85 individual or combined Maryland 8-digit watersheds by ensuring that each watershed has 10 or more sample sites. To achieve this sample density at the same annual level of effort, Round Two will take five years to complete (rather than the three years in Round One), running from 2000 through 2004. The details of the Round Two study design are presented Section 2.2 of this report.

The results of Round Two=s core survey will be presented in much the same way as for Round One. Unusual or rare or important species will be included to highlight our improving understanding of the state=s biodiversity. The status of sampled watersheds and individual stream segments will be reported, focusing on the conditions ratings of the fish and benthic IBI. Stressor results (for acidification, physical habitat, and nutrients) will be reported within and among watersheds. The 2002 report will also present preliminary comparisons with the Round One data and begin to discuss trends in the condition of Maryland=s streams. Individual sites= results for each watershed will be included, with additional information available on a Web-based searchable database at www.dnr.state.md.us/streams. The sampling frame for Round Two is based on a 1:100,000 scale map, and includes a substantial number of streams (primarily first-order) that were not included in the sampling frame used for Round One (1:250,000 map). In the estimation of differences in statewide stream condition between the two rounds, the bias resulting from differences in sampling

Table 1-1. Relative sizes of United States Geological Survey (USGS) and Maryland hydrologic units

	USGS 8-digit Cataloging Unit (MD 6-digit Basin)	**MD 8-digit Watershed**	**MD 12-digit Subwatershed**
Number in Maryland	20	138	1066
Average size in Maryland (approx.)	500 sq. mi.	75 sq. mi.	8 sq. mi.

frames can be corrected for by limiting the analysis to the population of streams that overlaps for the two sampling frames. The difference in map scale is likely to have only a small effect on parameters such as the mean IBI scores because the IBI scoring method is calibrated to adjust for effects of stream size on the expected number of species and other metrics. Results in Vølstad et al. (2001) suggest the mean fish IBI scores for an 8-digit watershed in Montgomery County (Seneca Creek) based on the County survey (1:24,000 map scale) is similar to the mean score based on the MBSS (1:100,000 scale).

While the data obtained from Round Two can still be aggregated to characterize basin or statewide conditions, the new design was intended primarily to provide estimates of stream condition at the smaller watershed level needed by many of the State=s watershed assessment and management programs and by local governments. For example, both the State=s Unified Watershed Assessment / Clean Water Action Plan and its interim biological criteria framework for non-tidal streams (MDE 2000) employ data to assess and rank Maryland 8-digit watersheds. The interim biocriteria framework for Maryland incorporates stream ratings based on fish and benthic IBIs developed by the MBSS (Roth et al. 2000, Stribling et al. 1998) to identify 8-digit watersheds and 12-digit subwatersheds that are impaired. Results from MBSS 2000 will be used to prepare the State=s Clean Water Act 303(d) list and 305(b) water quality report.

Although the Survey will provide the data needed to characterize the status of all 8-digit watersheds (averaging 75 mi^2 in area), it will not have sufficient sampling density to characterize most of the 1066 smaller 12-digit subwatersheds (averaging 8 mi^2 in area). Therefore, Round Two of the MBSS has been expanded by DNR to include a new volunteer effort (Maryland Stream Waders) and closer coordination with County stream monitoring programs. Maryland DNR is evaluating the feasibility of integrating data from these other monitoring programs by studying the comparability of each program=s sampling and analytical methods. By incorporating these data, the MBSS hopes to characterize many areas of the state at this finer spatial scale.

In 2000, Maryland DNR launched its volunteer-based Maryland Stream Waders initiative, a benthic sampling program. Each volunteer was trained by Maryland DNR staff in methods documented in the Maryland Stream Waders stream sampling manual (Boward 2001) and quality was assured through 5% duplicate sampling, taxonomic confirmations, and laboratory subsampling. In 2003, volunteers sampled 298 sites within twelve of the nineteen watersheds sampled by MBSS crews. A benthic family-level IBI was calculated for these sites (Stribling et al. 1998). Stream Wader results are presented in Chapter 4 of this report. For further information on Stream Waders, see http://www.dnr.state.md.us/streams/mbss/mbss_volun. html. The goals of the program are to:

- increase the density of sampling sites for use in stream and watershed quality assessments;
- improve stream stewardship ethics and encourage local action to improve watershed management;
- educate local communities about the relationship between land use and stream quality; and
- provide quality-assured information on stream quality to state, local, and federal agencies, environmental organizations, and others.

At the same time, Maryland DNR is working with several County (and Baltimore City) stream monitoring programs to coordinate monitoring and assessment efforts. Issues of study design, site selection, comparability of field and laboratory protocols, quality control, and integrated analysis are being addressed as cooperative efforts with the counties. For example, the MBSS and Montgomery County Department of Environmental Protection recently completed a EPA-sponsored case study that outlines general guidelines for integrating state and county programs (Roth et al. 2001a). Where feasible, the more spatially intensive monitoring results from the counties will be incorporated into MBSS reporting. Both state and county stream monitoring programs may also realize cost savings by sharing sampling results.

In addition to improving the spatial intensity of sampling, Round Two will address temporal variability by regular monitoring of fixed Asentinel@ sites. In 2000, DNR established a network of sentinel sites deemed to be minimally impacted by human activities. A total of 25 sentinel sites were selected in areas where land uses were unlikely to change over time (e.g., state parklands) from a pool of least-impacted reference sites identified in Round One (i.e., sites meeting designated water chemistry, physical habitat, and land use criteria). In 2003, 26 potential sentinel sites were sampled. Chapter 6 of this report describes sampling efforts at the Sentinel sites in 2003.

In addition, 30 sites were sampled in the C&O Canal during 2003 for the National Park Service.

1.3 ROADMAP TO THIS REPORT

This report presents the results of the 2003 annual sampling of Round Two of the MBSS and includes 8 chapters and 4 appendices. Chapter 2 provides a general description of the overall sampling design used in Round Two and describes Stream Wader results are presented in Chapter 4 of this report. For further information on Stream Waders, see the specific survey methods used. Chapter 2 also includes a brief description of the field and laboratory protocols and the statistical methods used in data analysis. Chapter 3 provides a comparative assessment of the watersheds sampled in 2003. Separate sections in Chapter 3 focus on biodiversity, biological indicator results, and three predominant issues affecting biological resources: acidification, physical habitat, and nutrients. Chapter 4 summarizes the sampling results for individual watersheds with tabular and map data. Chapter 5 compares the results of the 2003 sampling with Round One (1995-1997) of the Survey. Chapter 6 provides the results of sampling at MBSS sentinel sites. The conclusions of this report are presented in Chapter 7, focusing on management implications, dominant stressors, and emerging trends. References are in Chapter 8, while summary data tables and weather information are in the Appendices.

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2 METHODS

2.1 BACKGROUND

This chapter presents the study design and procedures used to implement Round Two of the Maryland Biological Stream Survey (MBSS or the Survey). Details of the study design and sample frame are included below, along with a summary of landowner permission results and the number of sites sampled in watersheds selected for sampling in 2003. This background material is followed by a summary of field and laboratory methods for each component: water chemistry, benthic macroinvertebrates, fish, amphibians and reptiles, vegetation, and physical habitat. Quality assurance (QA) activities are also described. For further details on Round Two methods, see the MBSS Sampling Manual (Kazyak 2001).

For the most part, methods used in Round Two of the MBSS (2000-2004) are identical to those of Round One (1995-1997). However, some changes were made to improve the quality and/or usefulness of the data generated. These changes in sampling methods include (1) modifications to the physical habitat assessment and characterization, (2) the addition of new chemical analytes (total nitrogen, nitrite, ammonia, orthophosphate, total phosphorous, chloride, and turbidity), (3) collection of continuous in-stream temperature readings at all randomly-selected sample sites throughout the summer, and (4) characterization of invasive terrestrial plant abundance. In addition, the reach file used to select sites is the 1:100,000-scale map developed by USGS; this is a change from the 1:250,000-scale map used in Round One. Another change to the sample frame is the expansion of the Survey to include fourth-order, non-tidal streams in addition to first- through third-order.

2.2 STATISTICAL METHODS

2.2.1 Survey Design

The second round of the MBSS is being conducted over five years and started in the year 2000. The Round Two Survey was designed to provide an assessment of stream condition in each of the Maryland 8-digit watersheds that contain non-tidal streams. It also facilitates the assessment of average stream condition over the five-year period for (1) the entire state, (2) the 17 major (Maryland 6-digit) drainage basins, and (3) other areas of interest such as counties and regions. The design was subject to the following level-of-effort constraints: (1) that a maximum of 300 sites be sampled per year, with approximately 210 allocated to the core random design, and (2) that the maximum sampling interval be 5 years.

2.2.2 Sample Frame

The sample frame for the 2000-2004 MBSS is based on the 1:100,000-scale stream network, a map scale consistent with that used by EPA and other states. The frame was constructed by overlaying the 138 Maryland 8-digit watershed boundaries (Figure 2-1) on a map of all stream reaches in the study area as digitized on a U.S. Geological Survey 1:100,000-scale map. It includes all non-tidal stream reaches of fourth-order and smaller, excluding impoundments that are non-wadeable or that substantially alter the riverine nature of the reach (see Kazyak 1994). Fourth-order streams were included to expand statewide coverage and ensure that all the streams classified as third-order by the 1:250,000 map (and sampled in the 1995-1997 MBSS) were also covered in the 2000-2004 MBSS. Four 8-digit watersheds (Atlantic Ocean, plus the Upper, Middle, and Lower Chesapeake Bay) were excluded from the sample frame because they describe marine/estuarine waters and do not contain non-tidal streams. Of the 134 watersheds included in the frame, 79 contained less than 100 non-tidal stream miles each; these were combined into 29 “super-watersheds” with between 2 and 7 constituent 8-digit watersheds each. When combined with the 55 remaining “stand alone” watersheds, a total of 84 watersheds of concern were identified as discrete primary sampling units (or PSUs) for Round Two (Table 2-1).

The Strahler convention (Strahler 1957) was used for identifying stream reaches in each 8-digit watershed by order. First order reaches, for example, are the most upstream reaches in the branching stream system. The designation of stream order for a particular reach depends on the scale and accuracy of the map.

2.2.3 Sample Selection

The second round of MBSS was restricted to a maximum of 300 sampling sites per year (210 within the core survey). Hence, it was not practical to stratify the network of streams in Maryland by 8-digit watersheds and

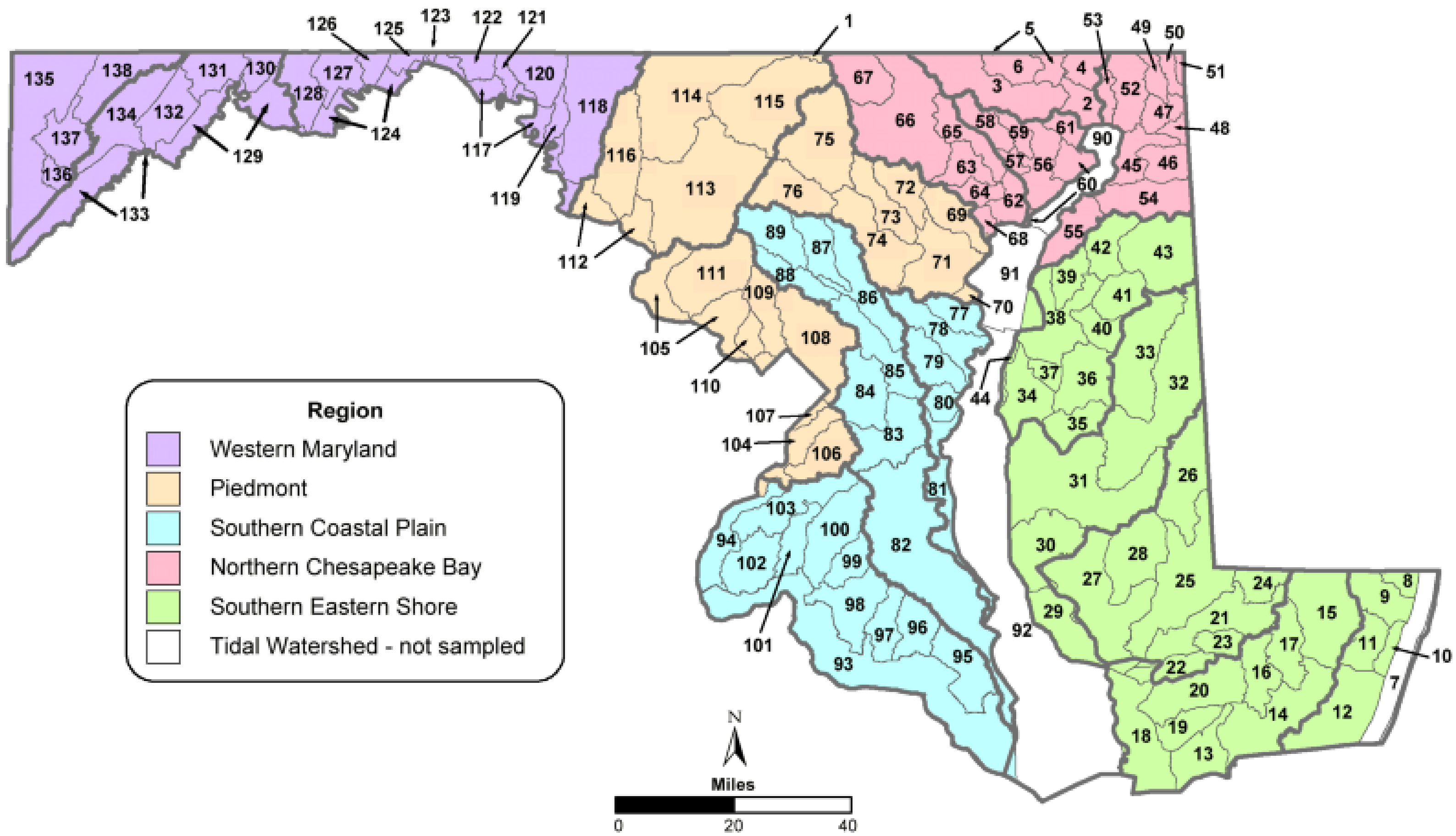

Figure 2-1. Maryland 8-digit watersheds by region

Table 2-1. Maryland individual and combined watersheds (primary sampling units or PSUs) to be sampled in the 2000-2004 MBSS. * indicates watershed selected that year for repeated sampling

Basin	Watershed	Watershed Number	2000	2001	2002	2003	2004	Extra Sites
Youghiogheny	Youghiogheny River	135		X				6
	Little Youghiogheny/Deep Creek Lake	136/137					X	
	Casselman River	138	X					
North Branch Potomac	Potomac River Lower North Branch	129				X		5
	Evitts Creek	130					X	
	Wills Creek	131					X	
	Georges Creek	132				X		
	Potomac River Upper North Branch	133		X				
	Savage River	134			X			4
Upper Potomac	Antietam Creek	118				X		4
	Potomac WA Co/Marsh Run/Tonoloway/Little Tonoloway	117/119/123/125	X		*			3
	Conococheague	120			X			
	Little Conococheague/Licking Creek	121/122					X	
	Potomac AL Co/Sideling Hill Creek	124/126		X				
	Fifteen Mile Creek	127	X					
	Town Creek	128	*		X			
Middle Potomac	Potomac River FR Co	112					X	
	Lower Monocacy River	113				X		11
	Upper Monocacy River	114	X					8
	Conewago Creek/Double Pipe Creek	1/115			X			7
	Catoctin Creek	116				X		4
Potomac Wash Metro	Potomac River MO Co	105			X			5
	Piscataway Creek	106		X				
	Potomac Upper Tidal/Oxon Creek	104/107		X				
	Anacostia River	108					X	5
	Rock Creek/Cabin John Creek	109/110				X		
	Seneca Creek	111		X				5
Patapsco	Back River	69			X			
	Bodkin Creek/Baltimore Harbor	70/71		X			*	
	Jones Falls	72			X			
	Gwynns Falls	73					X	
	Patapsco River Lower North Branch	74	X					4
	Liberty Reservoir	75	X			*		5
	South Branch Patapsco	76	X					

Table 2-1. (Continued)

Basin	Watershed	Watershed Number	2000	2001	2002	2003	2004	Extra Sites
Patuxent	Little Patuxent River	86	X					3
	Middle Patuxent River	87			X			
	Rocky Gorge Dam	88			X			
	Brighton Dam	89	X					
	Patuxent River Lower	82					X	8
	Patuxent River Middle	83		X				3
	Western Branch	84		X				
	Patuxent River Upper	85					X	
Lower Potomac	Breton/St. Clements Bays	96/97			X			
	Potomac Lower Tidal/Potomac Middle Tidal	93/94			*		X	
	St. Mary's River	95	*			X		
	Wicomico River	98					X	
	Gilbert Swamp	99		X				
	Zekiah Swamp	100		X				3
	Port Tobacco River	101				X		
	Nanjemoy Creek	102	X					
	Mattawoman Creek	103	X					
West Chesapeake	Magothy River/Severn River	77/78				X		
	South River/West River	79/80			X			
	West Chesapeake Bay	81				X		
Gunpowder	Gunpowder River/Lower Gunpowder Falls/Bird River/ Middle River-Browns	62/63/64/68			X			
	Little Gunpowder Falls	65		*		X		
	Loch Raven Reservoir	66			X			7
	Prettyboy Reservoir	67	X					
Susquehanna	Lower Susquehanna/Octoraro Creek/Conowingo Dam Susquehanna	2/4/5					X	
	Deer Creek	3		X			*	4
	Broad Creek	6				X		
Bush	Aberdeen Proving Ground/Swan Creek	60/61	X					
	Lower Winters Run/Atkisson Reservoir	57/58					X	
	Bush River/Bynum Run	56/59					X	
Elk	Northeast River/Furnace Bay	52/53		X				
	Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River	45/46/47/48/49/50/51				X		
	Sassafras River/Stillpond-Fairlee	54/55		X				

Table 2-1. (Continued)

Basin	Watershed	Watershed Number	2000	2001	2002	2003	2004	Extra Sites
Chester	Eastern Bay/Kent Narrows/Lower Chester River/ Langford Creek/Kent Island Bay	34/37/38/39/44			X			
	Miles River/Wye River	35/36				X		
	Corsica River/Southeast Creek	40/41	X					
	Middle Chester River	42			X	*		
	Upper Chester River	43					X	
Choptank	Honga River/Little Choptank/Lower Choptank	29/30/31				X		
	Upper Choptank	32	X					
	Tuckahoe Creek	33				X		
Nanticoke/Wicomico	Lower Wicomico/Monie Bay/Wicomico Creek/Wicomico River Head	21/22/23/24	X					
	Nanticoke River	25		*	X			
	Marshyhope Creek	26					X	
	Fishing Bay/Transquaking River	27/28					X	
Pocomoke	Pocomoke Sound/Tangier Sound/Big Annemessex/Manokin River	13/18/19/20				X		
	Lower Pocomoke River	14			X			
	Upper Pocomoke River	15		X				3
	Dividing Creek/Nassawango Creek	16/17		X				
Ocean Coastal	Assawoman/Isle of Wight/Sinepuxent/Newport/Chincoteague Bays	8/9/10/11/12		X				
Other	Upper Chesapeake Bay/Middle Chesapeake Bay/Lower Chesapeake Bay/Atlantic Ocean	90/91/92/7						
Total			18	19	19	19	19	107

sample them annually (i.e., only 2 sites could be sampled in each of the 134 watersheds each year under that design, resulting in unreliable estimates at the 8-digfit watershed scale). In addition, the costs of traveling to sample each year under that design, resulting in unreliable estimates at the 8-digit watershed scale). In addition, the costs of traveling to sample each watershed each year would be high, resulting in fewer than 210 sites being sampled annually. As an alternative to stratifying by watershed, the Survey designated the 84 watershed units of concern (both 55 single watershed units and 29 super-watersheds) as primary sampling units (PSUs). A subset of the 84 PSUs is selected randomly each year, with restrictions to ensure that all 8-digit watersheds are sampled once during the five-year sampling period. Using this approach, a representative sub-set of watersheds are studied each year, covering all the 84 watersheds of concern over a five-year period.

2.2.3.1 Lattice Sampling of Watersheds (PSUs)

Lattice sampling was used to schedule the sampling of all 84 watersheds (PSUs) over a 5-year period (see Cochran 1977; Jessen 1978). A sampling frame for selecting watersheds across time was formed by arranging the PSUs into a lattice with 84 rows and one column for each year (Table 2-1).

The 84 PSUs were stratified into five physiographic regions (strata) to ensure that their sampling is spread out geographically during each sample year (Figure 2-2). These five regions include whole major (Maryland 6-digit) drainage basins and divide the State into approximately equal parts. This stratification by region was done to spread out the sampling in space and thereby increase precision in statewide estimates; the geographic strata are not considered important reporting units.

A first-stage random sample of PSUs is drawn from each region in each year, with restrictions to ensure that all 84 watersheds (PSUs) of concern are sampled at least once during the 5-year sampling period. The lattice sampling supports an estimate of average statewide condition over the 5-year period. This strategy is similar to the lattice design used in the 1994 Demonstration Study (Vølstad et. al 1996) and the 1995-1997 MBSS Round One design (Roth et al. 1999); it takes into account the restrictions in annual sampling effort. About one-fifth of the watersheds in each of the five regions are randomly selected (without replacement) each year. In addition, two randomly selected watersheds in each region are being sampled twice during the five-year Survey (in randomly selected years). The representative sampling over time, augmented by repeated sampling of watersheds, ensures that all PSUs and pairs of PSU combinations have a known probability (greater than zero) of being selected. This probability-based sampling facilitates the estimation of statewide average condition over the 5-year study period with quantifiable precision based on the Horvitz-Thompson estimator (Horvitz and Thompson 1952; Thompson 1992). It also allows estimation of statewide conditions for each year of the Survey.

2.2.3.2 Stratified Random Sampling within PSUs

Within each PSU, the elementary sampling units from which field data are collected (i.e., the 75-m stream segments or sites) are selected using either stratified random sampling with proportional allocation, or simple random sampling (Cochran 1977). This allocation ensures that all sites in a PSU stream network have the same probability of being selected. The target sample size in each PSU is a minimum of 10 sites for the spring benthic sampling. Because of imperfections in the sample frame, a list of random replacement sites is provided for each PSU.

When the Round Two design was proposed, the target minimum of 10 sites per PSU was determined by analyzing the expected variability in IBI mean scores and percentage stream mile estimates as a function of varying sample size. Analysis (as presented in Southerland et al. 2000) indicated that fewer than 10 sites per PSU would not yield sufficient precision in stream mile estimates. Working with DNR, the survey designers determined that 10 sites per watershed would yield a minimum acceptable level of precision while remaining within other design constraints (i.e., the annual level of effort available for sampling and the maximum sampling interval of five years for the statewide survey).

When feasible, the streams in each of the 55 PSUs consisting of a single 8-digit watershed were grouped into two strata based on stream order. One stratum includes all the first- and second-order streams, while the other includes all the third- and fourth-order streams. The number of sites in each of the two strata are allocated proportional to their stream length, resulting in equal sampling density for the two strata. In watersheds where the proportion of stream miles in one stratum (e.g., third- and fourth-order streams) is significantly below 10%, the stringent proportional allocation could not be achieved because it would result in allocation of less than one sample site to this stratum. Samples were not forced into strata that contained a minimal portion of stream miles, because this would eliminate the simplicity of equal probability sampling. Instead, the strata for such PSUs were collapsed, and a simple random sample of sites from all streams was selected.

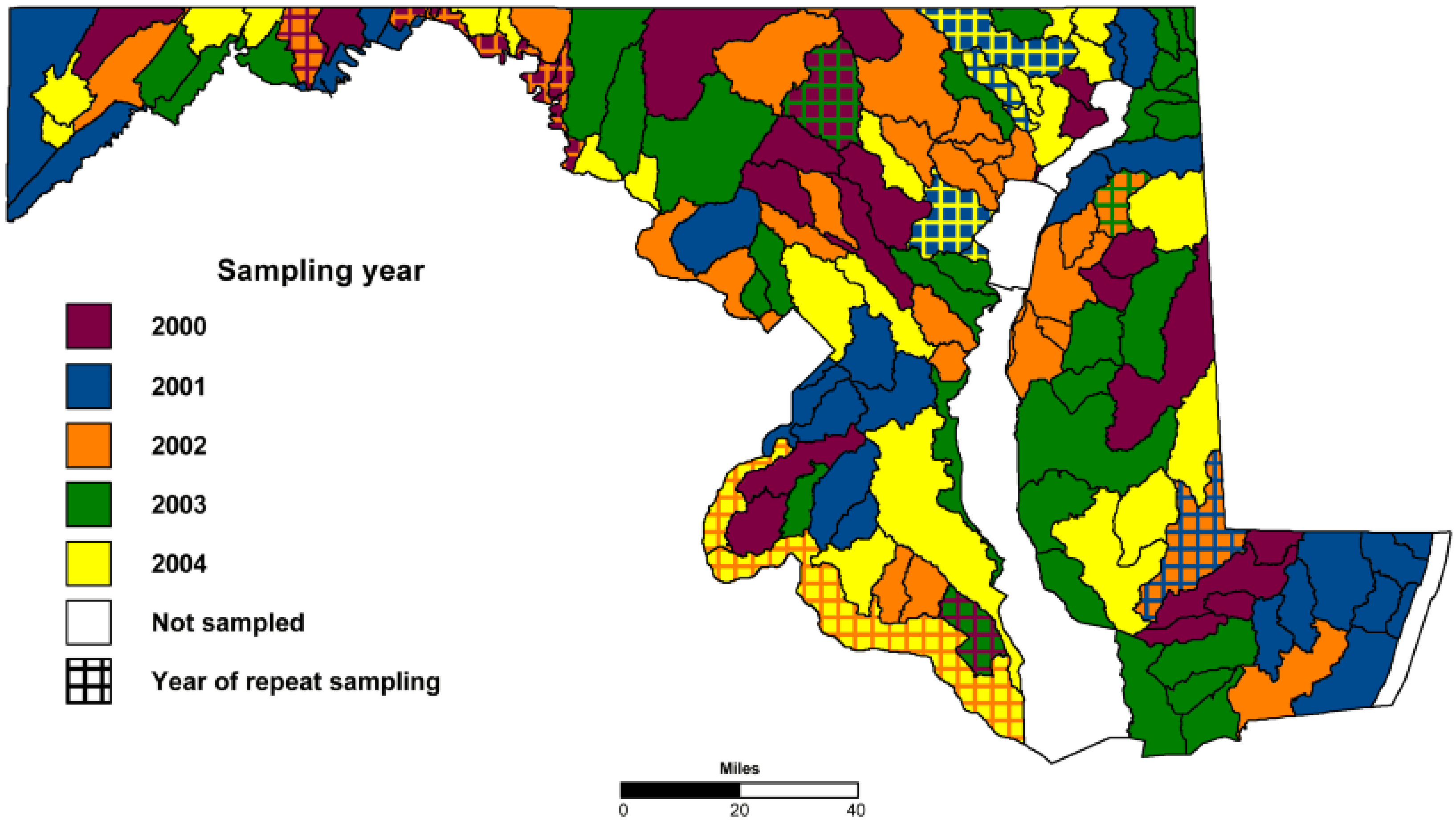

Figure 2-2. MBSS 2000-2004 Primary sampling Units (PSU)s and sampling schedule

A different stratification was used for the 29 PSUs consisting of more than one 8-digit watershed (i.e., the super-watersheds). For these PSUs, each constituent 8-digit watershed was designated a stratum, and the strata receive equal sampling fractions (i.e., proportional to stream miles in each 8-digit watershed). This stratification of super-watersheds was done to ensure that the non-tidal streams in each individual 8-digit watershed were sampled. While this approach may increase precision of stratified estimates for the super-watershed, the precision in estimates for individual 8-digit watersheds will generally be low because of low sample sizes. The limited sample sizes allocated to each PSU did not allow further stratification of the super-watersheds by stream order.

When one or more of the initial sample of stream segments in a PSU could not be sampled (e.g., dry stream or no permission to access), the stratification of the PSU was abandoned, and the replacement sites were selected from a list of simple random sites. This adjustment was made because the fraction of unsampleable sites cannot be adequately quantified for individual strata with low sample sizes.

2.2.3.3 Allocation of Additional Sites to Large Watersheds

Additional sites were allocated to 22 watersheds with more than 100 non-tidal stream miles. Increased sample sizes in these watersheds will reduce the variance of key estimates and improve statewide estimates (by more closely approximating statewide allocation proportional to stream miles). Over the five-year Survey, a total of 107 additional sites were allocated proportional to stream miles within these large watersheds (Table 2-2).

2.2.4 Site Selection

- Sample Frame Construction. The stream order of each reach was attributed on the 1:100,000-scale USGS Digital Line Graph (DLG) maps. If necessary, 1:24,000-scale USGS topographic maps were used as references to identify flow patterns or to see more detail. Where necessary, maps from Pennsylvania and Delaware were used to identify the stream order of water bodies originating outside of Maryland.

Table 2-2. List of MBSS Round Two Primary Sampling Units with greater than 100 non-tidal stream miles, scheduled for additional sample sites above a minimum of ten.

Primary Sampling Unit	Number of Stream Miles	Number of Additional Sites
Lower Monocacy River	388.39	11
Upper Monocacy River	284.38	8
Patuxent River Lower	280.90	8
Loch Raven Reservoir	237.10	7
Conewago Creek/Double Pipe Creek	231.16	7
Youghiogheny River	222.56	6
Liberty Reservoir	184.08	5
Seneca Creek	178.85	5
Potomac River Lower North Branch	165.45	5
Potomac River MO Co	160.68	5
Anacostia River	159.34	5
Antietam Creek	146.34	4
Deer Creek	142.62	4
Patapsco River Lower North Branch	129.50	4
Catoctin Creek	128.95	4
Savage River	127.13	4
Upper Choptank	127.02	4
Little Patuxent River	122.48	3
Zekiah Swamp	120.75	3
Potomac WA Co/Marsh Run/Tonoloway/Little Tonoloway	118.43	3
Patuxent River Middle	111.19	3
Upper Pocomoke River	109.65	3

- Random Site Picks. Once the sample frame was developed for a PSU, sites were randomly assigned according to the stratified design described above using a FORTRAN-based program. If the proportion of stream miles in the smallest strata (either stream-order-based in single watershed PSUs or watershed-based in the super-watersheds) was greater than or equal to 10%, sites were allocated proportionally among strata; if it was less than 10%, the strata were collapsed and sites allocated by simple random sampling. After the target number of sites was selected (10 to 21 sites depending on PSU size), a simple random selection of "extra sites" to a total of 50 was chosen in each PSU using the GIS. This was done to ensure that a sufficient number of sites remained available for sampling after permission denials and unsampleable sites were removed from consideration.

- Each sample point chosen on the GIS was designated as the midpoint of the 75-m sampling segment in the field. Sites selected less than 75 meters from another randomly-selected site (both upstream and downstream) were eliminated. Sites that could possibly cross stream network nodes were not eliminated from the program; it was assumed that these sites could be adjusted in the field by moving the starting point away from the node, but staying within the designated stream order.

Each site was then attributed with the following information:

- stream order
- county
- basin
- physiographic region
- northing, easting
- latitude and longitude (both in decimal degrees and in degrees, minutes, seconds)
- watershed name and MD 8-digit watershed code.

2.2.5 Permissions from Landowners

- Extra Permissions. Permission was solicited to sample from landowners at twice the number of sites allocated to each PSU by the design (usually 20 sites, but from 26 to 42 in the larger watersheds). While the allocated number of sites (usually 10) were selected from the appropriate strata (see above), the "extra sites" were chosen to fill out the list, regardless of stream order. At the completion of site selection for each county, sites were sent to DNR for generation of 1:24,000-scale topographic maps and communication of sites to local governments planning to conduct their own stream monitoring programs.

- Landowner Identification. Each site was plotted on county tax maps using the Maryland Office of Planning Maryland Property View System obtained from DNR. From this, property owners could be identified, both for the site containing the sampling site and for any areas required to access the stream. Phone numbers were obtained from the internet using a white pages directory (http://www.switchboard.com).

- Landowner Contact. Letters were prepared requesting permission to access the property, including a written form and telephone contact information through which the landowner could respond. The letter also provided a MBSS brochure and telephone number to call for more information. If no response was received from the mailings and the phone number was listed, the property owner was called and permission to access the site was requested. If the owner gave permission, the caller requested additional information about the site, such as whether the stream was often dry or hard to access. The caller also recorded whether the crew needed to make a pre-visit call to the landowner or whether the owner had to be available to open gates or walk the crew through the property. All property owner information was entered and maintained in a Microsoft Access database.

- Field Crew Information. Permission packets were then prepared for the field crews. Packets contained a printout of the property owner information for each site and a tax map showing possible access routes. The callers attempted to obtain permissions for the target sites in the proportions that stream orders occur in each PSU. In addition, permissions were obtained for extra sites (up to 50% more than the targeted number) to account for non-sampleable sites. In some PSUs where obtaining permission proved difficult, the owners of additional sites were conducted and permission was obtained. These extra sites represent a simple random sample and may or may not be of the same stream order as the originally selected sites (for example, if a third- to fourth-order site was unsampleable, the replacement site was the next on the simple random list, regardless of stream order).

2.3 ANALYTICAL METHODS

2.3.1 Estimation of Means, Proportions, and Totals Within Watersheds (PSUs)

2.3.1.1 Standard Estimators for the MBSS Sampling Program

The MBSS sampling design within watersheds (PSUs) involves simple random sampling, or stratified random sampling with proportional allocation of sites across the *L* strata. Standard PSUs have two strata based on stream order, while the strata in "super-watersheds" consist of the constituent 8-digit watersheds (Table 2-3).

Table 2-3. The following symbols refer to the population of streams and the sample of sites.

Population	Sample	Defined as
N_r	n_r	Number of watersheds (PSUs) in region *r*
M_{rih}	m_{rih}	Number of 75-m sites in stratum *h* within PSU *i* in region *r*. A standard PSU has two strata: (1) 1st - 2nd order streams; and (2) 3rd - 4th order streams. For super-watersheds, the number of strata is equal to the number of 8-digit watersheds within the PSU.
Y_{rihj}	y_{rihj}	Variable of interest associated with site j, j=1,2,...,m_{rih}

For simplicity the subscript *r* for region in the estimators for watersheds was not included. For PSUs with collapsed strata, estimates of means, totals, and proportions are based on the standard estimators for simple random sampling (Cochran 1977).

For PSUs where stratification could be achieved, stratified estimators were used. Suppose m_{ih} sites are chosen randomly in stratum *h*, within watershed *i*, and, at each site *j*, measurements are collected for the variable of interest y_{ihj}. Standard stratified estimators (Cochran 1977) are used to estimate means, proportions, and totals when all randomly selected sites in watershed *i* are sampleable, and the number of stream miles can be determined directly from the sample frame. An estimator for the mean of the variable of interest *y* is

$$\bar{y}_i = \sum_{h=1}^{L} w_h \bar{y}_h$$

where

$$\bar{y}_h = \frac{1}{m_{ih}} \sum_{j=1}^{m_{ih}} y_{ijk}$$

is the mean of *y* for watershed *i* within stratum *h* and w_h is the proportion of stream miles in the stratum (determined from the sample frame). The variance of the stratified mean for *y* in watershed *i* is

$$Var\left(\bar{y}_i\right) = \sum_{h=1}^{L} w_{ih}^2 \frac{s_{ih}^2}{m_{ih}}$$

where

$$\sum \left(\frac{y_{ihj} - \bar{y}_{ih}}{m_{ij}} \right)^2$$

is the sample variance for the variable of interest in stratum *h* for watershed *i*. An estimator for the standard error of $\bar{y}_i$ is

$$\sqrt{Var\left(\bar{y}_i\right)} \, .$$

The same estimators can be used to estimate proportions of stream miles in a specific class by introducing an indicator variable that takes the value 1 when the variable *y* meets the condition (e.g., pH < 6), and zero otherwise. The mean of this indicator using the estimators above is an estimate of the proportion of stream miles within the specific class (e.g., proportion of stream miles with pH < 6). When estimating proportions, the MBSS samples can be treated as repeated independent samples of binary observations (1 if pH < 6, and 0 otherwise) because the samples have equal inclusion probabilities. An exact confidence interval for an estimated proportion (p) is obtained from the binomial distribution (Collett 1999, pp. 23-24), with lower and upper confidence bounds

$$p_L = y[y + (n - y + 1)F_{2(n-y+1),2y}(\alpha/2)]^{-1}$$

$$p_U = (y+1)[y + 1 + (n-y)F_{2(y+1),2(n-y)}(\alpha/2)]^{-1}$$

respectively, where $F_{v1,v2}\left(\alpha/2\right)$ is the upper $\left(100\alpha/2\right)$% point in the F-distribution with v_1 and v_2 degrees of freedom, and y is the observed number of successes (e.g., number of sites with IBI < 3) out of the n observations in a watershed.

An estimator for the total of a variable of interest (e.g., number of fish) in a watershed i is obtained by extrapolating the mean to all stream miles

$$\bar{Y}_i = M_i \bar{y}_i$$

with standard error

$$M_i \sqrt{Var(\bar{y}_i)}.$$

In practice some of the random sites selected in a watershed i may fall outside the defined target streams for MBSS. During periods of drought, for example, sections of streams represented on the 1:100,000-scale map used in MBSS may not exist. Also, because of imperfections in the sample frame, some selected sites may fall outside the actual network of target streams defined by MBSS. Loss of samples was anticipated in the MBSS, and a list of randomly selected replacement sites was provided for the sampling crews. For the MBSS, estimates are made for the target streams, which may be a subpopulation of streams within an imperfect sample frame. This subpopulation is referred to as a *domain of study* (U.N. Subcommission on Sampling 1950).

For the MBSS, unsampleable streams are outside the domain of study. In this case, the Survey is interested in estimating parameters for the domain of study, i.e., for "MBSS target streams." All samples in watershed i can be treated as a simple random sample of size m_i, because samples were allocated to strata proportional to their stream length. This assumption is reasonable because the sampling fractions in the strata are equal, and each stream site has the same probability of being selected. Let the domain of study (MBSS target streams) in watershed i contain M'_{di} stream miles, and let m'_i be the number of sites of the simple random sample of size m_i that happens to fall in this domain. If (k=1,2,…, m'_i) are the measurements of the variable of interest from these sites, the mean for domain d is estimated by

$$\bar{y}_{id} = \sum_{k=1}^{m'_i} \frac{y'_k}{m'_i}$$

and an estimate for the standard error of $\bar{y}_{id}$ is

$$\frac{S_{id}}{\sqrt{m'_i}}$$

where

$$S_{id}^2 = \sum_{k=1}^{m'_i} \frac{\left(y'_k - \bar{y}_{id}\right)^2}{m'_i - 1}$$

The finite population correction factor can safely be ignored because the sampling fraction (i.e., the number of 75-m segments sampled relative to all available) within each watershed is small.

2.3.1.2 Estimators for Combining MBSS with Additional Probability-based Sampling Programs

When additional MBSS compatible data for a watershed are available from a probability-based sampling program, it is possible to combine the data by using a composite estimator (Vølstad et al. 2002). Assume that MBSS and a County program provide simultaneous estimates of the mean IBI for a watershed, and that the total length of streams covered by each survey j is L_j. The combined mean IBI for the watershed can then be estimated by a linear combination of the individual survey weighted means (Korn and Graubard 1999) $\bar{y}_1$ and $\bar{y}_2$,

$$\bar{y} = \frac{(k_1 L_1)\bar{y}_1 + (k_2 L_2)\bar{y}_2}{k_1 L_1 + k_2 L_2}.$$

If $\bar{y}_1$ and $\bar{y}_2$ are approximately unbiased for the population mean IBI, then $\bar{y}$ will also be unbiased. The variance of $\bar{y}$ is minimized by using the weights

$$k_j = \frac{L_1 + L_2}{2L_j}\left(1 - \frac{Var(\bar{y}_j)}{Var(\bar{y}_1) + Var(\bar{y}_2)}\right),$$

which grant more influence to precise estimates and greater survey coverage.

To estimate the variance of the combined mean $\bar{y}$ assume that each survey j has S_j number of strata; j = 1,2. The population of stream segments in the watershed is treated as if it was composed of $S = S_1 + S_2$ strata. This stratification controls for survey differences (Korn and Graubard 1999). When the two surveys are independent,

$$Var(\bar{y}) = \sum_{i=1}^{s} w_i^2 Var(\bar{y}_1)$$

where the strata weights

$$w_i = \frac{L_i}{\sum_{i=1}^{S} L_i}$$

are the fractions of the total stream length (for both surveys) in each stratum. An estimator for the standard error of $\bar{y}$ is

$$\sqrt{Var(\bar{y})}\,.$$

The same estimators can be used to estimate proportions of stream miles in a specific class by introducing an indicator variable that takes the value 1 when the variable *y* meets the condition (e.g., pH < 6), and zero otherwise. The mean of this indicator using the estimators above is an estimate of the proportion of stream miles within the specific class (e.g., proportion of stream miles with pH < 6). The estimation of exact confidence intervals for pooled data based on the binomial distribution (section 2.3.1.1) is valid only if the County program also employs simple random or an equivalent sampling design.

2.3.1.3 Estimators for Combining MBSS Data Across Sampling Rounds

While IBI data from the two rounds (e.g., 1996 and 2000 data) cannot simply be pooled because of the different study designs, the mean IBIs from the two rounds can be combined. In a watershed where there are sufficient samples in each round to calculate a mean and standard error, the estimates for each round can be combined into a single estimate using composite estimation (Korn and Graubard 1999). It is recommended that the combined estimate only be applied when the combined data represent an effective sample size of at least 10 samples. For MBSS Round One, a minimum of two samples per stratum are required (i.e., two samples in each of stream orders 1, 2, and 3).

Assume that two rounds provide estimates for the same population of streams, as defined on the 100,000 scale map, and that the two surveys were independent. Under this assumption temporal differences in the actual stream network caused by variation in rainfall or other factors are not taken into account. Let $\bar{x}_1$ and $\bar{x}_2$ be the mean IBIs for two rounds, with respective standard errors SE_1 and SE_2 calculated according to the respective survey design.

Equal weights are assigned to each year's estimate, and use the simple combined estimator

$$\bar{x} = \frac{\bar{x}_1 + \bar{x}_2}{2}$$

for the pooled mean IBI, with variance

$$\operatorname{var}(\bar{x}) = \frac{1}{4}\left\{\operatorname{var}(\bar{x}_1) + \operatorname{var}(\bar{x}_2)\right\}$$

and standard error

$$SE = \frac{1}{2}\sqrt{SE_1^2 + SE_2^2}\,.$$

This simple approach was applied to avoid that the combined mean would be driven by the estimate for one particular year. When more than one survey is conducted in a watershed during the same year it is recommended that the means be weighted based on sample sizes or their variances (Korn and Graubard 1999). When significant differences occur between the sampling frames for two surveys in a watershed because of differences in maps scale (1:24,000 verus 100,000, for example), and their variances this should also be accounted for by adjusting the weights (Korn and Graubard 1999; Vølstad et al. 2002).

The difference in map scale between the two MBSS sampling rounds (1:250,000 versus 1:100,000) is likely to have only a small effect on the mean IBI scores because the network of streams on the two maps approximately overlaps. The 1:100,000 map includes a certain number of small headwater streams that are not included on the 1:250,000 map. However, the MBSS IBI scoring is only applied to streams in catchments over 300 acres, and thus it is reasonable to assume that the target population of streams are the same across rounds.

2.3.1.4 Testing for Differences in Mean IBI Scores Between Years

Comparisons of statistical differences between mean IBI scores from two years were conducted using the standard method recommended by Schenker and Gentleman (2001). This test was used because it is more robust than the commonly used method of examining the overlap between the two associated confidence intervals. Assume that $\hat{Q}_1$, and $\hat{Q}_2$ are two independent estimates of mean IBI, and that the associated standard errors (*SE*) are estimated by $\hat{S}E_1$ and $\hat{S}E_2$. We estimated the 95% confidence interval for $\hat{Q}_1 - \hat{Q}_2$ by

$$\left(\hat{Q}_1 - \hat{Q}_2\right) \pm 1.96\left[\hat{S}E_1^2 + \hat{S}E_2^2\right]^{1/2}$$

and tested (at 5% nominal level) the null hypothesis that $\hat{Q}_1 - \hat{Q}_2 = 0$ by examining whether the 95% confidence interval contains 0. The null hypothesis that two estimates are equal was rejected if and only if the interval did not contain 0 (Schenker and Gentleman 2001).

2.4 LANDOWNER PERMISSION RESULTS

As discussed in Section 2.2.5, permissions were obtained to access privately owned land adjacent to or near each stream segment. For 2003, the overall success rate for obtaining permissions was 55% (Table 2-4). Cases where permissions were not obtained included both denials (14%) as well as non-responses (31%), when landowners were unable to be reached and did not respond to letters and telephone messages. The success rate was 82% for landowners who responded to phone or letter permission requests. Reasons for permission denial varied widely and generally reflected the preferences of individual landowners regarding property access, rather than any specific types of land. In rare cases, permission denial may affect the interpretation of MBSS estimates, but only where denials occur in streams with characteristics that differ from the general population of streams. During 2003 sampling, it did not appear that permission denials affected MBSS estimates although it was felt by field crews that permission denials in some PSUs may have resulted in more sites sampled on public lands than was proportionate to the amount of public land in the PSU.

2.5 NUMBER OF SITES SAMPLED IN 2003

As stated in Section 2.2.3.2 above, the target sample size in each PSU is a minimum of 10 sites for the spring benthic sampling. Additional sites were allocated to the larger PSUs sampled in 2003: Lower Monocacy River (11 extra), Potomac River Lower North Branch (5 extra), Liberty Reservoir (5 extra), Antietam Creek (4 extra), and Catoctin Creek (4 extra). Table 2-5 lists the number of sites sampled for spring benthic, physical habitat, and water chemistry sampling. For all PSUs, the number of sites actually sampled equaled or exceeded the target number specified in the design. Twenty-one sites were unsampleable in the spring for a variety of reasons, including dry stream beds and impoundments.

Table 2-4. Landowner permission success rates for Primary Sampling Units (PSUs) sampled in the 2003 MBSS

PSU	Number of Stream Segments Targeted as Potential Sample Sites	Success Rate	No Response	Denial Rate
Potomac River L N Br	30	60%	33%	7%
Georges Creek	20	55%	40%	5%
Antietam Creek	30	53%	34%	13%
Lower Monocacy	40	50%	30%	20%
Catoctin Creek	20	60%	10%	30%
Rock Creek/Cabin John Creek	20	60%	40%	0%
Liberty Reservoir	30	50%	50%	0%
St. Marys River	20	60%	20%	15%
Magothy/Severn Rivers	20	75%	25%	0%
Port Tobacco River	20	50%	40%	10%
West Chesapeake Bay	20	55%	45%	0%
Little Gunpowder Falls	20	60%	15%	25%
Broad Creek	20	50%	0%	50%
Lower Elk River PSU	20	55%	45%	0%
Miles/Wye Rivers	20	50%	50%	0%
Middle Chester River	20	70%	25%	5%
Honga River PSU	30	33%	33%	33%
Tuckahoe Creek	20	50%	30%	20%
Pocomoke Sound PSU	20	55%	15%	30%
TOTAL	440	55%	31%	14%

Table 2-5. Number of sites sampleable in the spring for MBSS 2003 PSUs				
PSU	**Number of Unsampleable Sites**	**Number of Benthic Sites**	**Number of Spring Habitat Sites**	**Number of Spring Water Quality Sites**
Potomac River L N Br	2	15	15	15
Georges Creek	0	10	10	10
Antietam Creek	4	14	14	14
Lower Monocacy	3	21	21	21
Catoctin Creek	0	14	14	14
Rock Creek/Cabin John Creek	0	10	10	10
Liberty Reservoir	1	15	15	15
St. Marys River	1	10	10	10
Magothy/Severn Rivers	0	10	10	10
Port Tobacco River	0	10	10	10
West Chesapeake Bay	1	10	10	10
Little Gunpowder Falls	0	10	10	10
Broad Creek	1	10	10	10
Lower Elk River PSU	2	10	10	10
Miles/Wye Rivers	0	10	10	10
Middle Chester River	5	10	10	10
Honga River PSU	0	10	10	10
Tuckahoe Creek	1	10	10	10
Pocomoke Sound PSU	0	10	10	10
TOTAL	21	219	219	219

During summer sampling, a number of sites that had been sampled in the spring were unsampleable for several reasons, the most common being that the stream had dried up. Table 2-6 lists the number of sites that were electrofished during the summer of 2003. It also lists the number of sites where summer habitat and water quality measures were taken, as well as the number of sites where amphibians and reptiles, mussels, and aquatic vegetation were qualitatively sampled.

2.6 FIELD AND LABORATORY METHODS

2.6.1 Spring and Summer Index Periods

Benthic macroinvertebrate and water quality sampling were conducted in spring, when acidic deposition effects are often the most pronounced. While it is recognized that several different index periods may be used for benthic sampling, the MBSS chose the spring index period for logistical purposes. Fish, amphibian, reptile, and aquatic vegetation surveys, along with physical habitat evaluations, were conducted during the low-flow period in summer. Fish community composition tends to be stable during summer, and low flow is advantageous for electrofishing.

Because low-flow conditions in summer may be a primary factor limiting the abundance and distribution of fish populations, most of the habitat assessment was performed during the summer.

To reduce temporal variability, sampling was conducted within specific, relatively narrow time intervals, referred to as index periods. The spring index period was defined by degree-day limits for specific parts of the state. The spring index period was between March 1 and about May 1, with the end of the index period determined by degree-day accumulation as specified in Hilsenhoff (1987). In 2003, all spring samples were collected by the end of April, well before degree-day accumulation limits were approached. The targeted summer index period was between June 1 and September 30 (Kazyak 2001). In 2003, all summer sampling was completed by the end of September, before the end of the targeted index period. While the spring index period is two months in duration because of changing weather conditions (possible rapid warming leading to changes in stream condition), the summer index period is four months long because weather conditions are more consistent throughout the season and fish sampling is more time consuming.

Table 2-6. Number of sites sampleable in the summer for MBSS 2003 PSUs						
PSU	**Number of Sites Fished**	**Number of Summer Habitat Sites**	**Number of Summer Water Quality Sites**	**Number of Sites - Amphibians and Reptiles**	**Number of Sites - Mussels**	**Number of Sites - SAV**
Potomac River L N Br	15	15	15	15	15	15
Georges Creek	10	10	10	10	10	10
Antietam Creek	12	12	12	12	12	12
Lower Monocacy	20	20	20	20	20	20
Catoctin Creek	12	12	12	12	12	12
Rock Creek/Cabin John Creek	10	10	10	10	10	10
Liberty Reservoir	15	15	15	15	15	15
St. Marys River	10	10	10	10	10	10
Magothy/Severn Rivers	9	9	10	10	10	10
Port Tobacco River	10	10	10	10	10	10
West Chesapeake Bay	10	10	10	10	10	10
Little Gunpowder Falls	9	9	9	9	9	9
Broad Creek	10	10	10	10	10	10
Lower Elk River PSU	10	10	10	10	10	10
Miles/Wye Rivers	10	10	10	10	10	10
Middle Chester River	10	10	10	10	10	10
Honga River PSU	10	10	10	10	10	10
Tuckahoe Creek	9	9	9	10	9	9
Pocomoke Sound PSU	10	10	10	10	10	10
TOTAL	211	211	212	213	212	212

2.6.2 Water Chemistry

During the spring index period, water samples were collected at each site for analysis of water quality conditions, with an emphasis on factors related to acidic deposition and nutrients (Table 2-7). Grab samples were collected in 0.5 and 1-liter bottles for analysis of all analytes except pH. Water samples for pH were collected with 60 ml syringes, which allowed purging of air bubbles to minimize changes in carbon dioxide content (EPA 1987). Samples were stored on wet ice and shipped on wet ice to the analytical laboratory within 48 hours. The requirement to filter for some analytes within 48 hours was exceeded by several hours for some samples. Laboratory analyses were carried out by the University of Maryland's Appalachian Laboratory in Frostburg.

Chemical analysis of water samples followed standard methods as listed in Table 2-7. Routine daily quality control (QC) checks included processing duplicate, blank, and calibration samples according to EPA guidelines for each analyte. Field duplicates were taken at 5% of all sites. Routine QC checks helped to identify and correct errors in sampling routines or instrumentation at the earliest possible stage. Standard operating procedures were implemented that detail the requirements for the correct performance of analytical procedures. The internal QA/QC protocols followed guidelines outlined in EPA (1987). The complete QA/QC report for 2003 MBSS laboratory analysis can be found in Kline and Morgan (2003). QC results were examined in conjunction with site data and are summarized in a separate report (Rogers et al. 2004).

During the summer index period, *in situ* measurements of dissolved oxygen (DO), pH, temperature, and conductivity were collected at each site to further characterize existing water quality conditions that might influence biological communities. Measurements were made at an undisturbed section of the segment, usually in the middle of the stream channel and at the upstream segment boundary, using electrode probes. Instruments were calibrated daily and calibration logbooks were maintained to document instrument performance. In 2003, there were no quality assurance problems apparent in log books and other documentation (Rogers et al. 2004).

Table 2-7. Analytical methods used for water chemistry samples collected during the spring index period				
Analyte (units)	**Method**	**Instrument**	**Detection Limit**	**Holding Time (days)**
pH (standard units)	EPA (1987) Method 19	Orion pH meter	0.01	7
Acid neutralizing capacity (μeq/l)	EPA (1987) Method 5	Brinkmann Automated Titration System equipped with customized software	0.01	14
Sulfate (mg/l)*	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.03	14
Nitrite nitrogen* (mg/l)	EPA (1999) Method 354.1	Lachat QuikChem Automated Flow Injection Analysis System	0.0005	28 (frozen)
Nitrate nitrogen* (mg/l)	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.01	14
Ammonia (mg/l)*	EPA (1999) Method 350.1	Lachat QuikChem Automated Flow Injection Analysis System	0.003	28 (frozen)
Total nitrogen (mg/l)*	APHA (1998) 4500-N (B)	Lachat QuikChem Automated Flow Injection Analysis System w/In-line Digestion Module	0.050	28 (frozen)
Orthophosphate (mg/l)*	APHA (1998) 4500-P (G)	Lachat QuikChem Automated Flow Injection Analysis System	0.0010	28 (frozen)
Total phosphorus (mg/l)*	APHA (1998) 4500-P (I)	Lachat QuikChem Automated Flow Injection Analysis System w/In-line Digestion Module	0.0013	28 (frozen)
Chloride (mg/l)*	EPA (1987) Method 11	Dionex DX-500 Ion Chromatograph (AS-9 HC column)	0.02	14
Specific conductance (μmho/cm)	EPA (1987) Method 23	YSI Conductance Meter w/Cell	0.1	7
Dissolved organic carbon (mg/l)*	EPA (1987) Method 14	Dohrmann Phoenix 8000 Organic Carbon Analyzer	0.14	28
Particulate carbon (mg/l)	D'Elia et al. (1997)	CE Elantech N/C Analyzer	0.0595	
* Indicates analyses that require filtration within 48 hours				

2.6.3 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected to provide a semi-quantitative description of the community composition at each sampling site. Sampling was conducted during the spring index period. Benthic community data were collected primarily for the purpose of calculating DNR's Benthic Index of Biotic Integrity (BIBI) for Maryland streams (Stribling et al. 1998). Recognizing that Maryland streams vary from high-gradient riffle habitat with abundant cobble substrate to low-gradient Coastal Plain streams with sandy or silty bottoms, MBSS employs a "D" net suitable for sampling a wide variety of habitats. This multi-habitat approach is consistent with the recommendations of the Mid-Atlantic Coastal Streams Workgroup (MACS 1996) and the EPA's most recent Rapid Bioassessment Protocols (Barbour et al. 1999).

At each segment, a 600-micron mesh "D" net was used to collect organisms from habitats likely to support the greatest taxonomic diversity. This habitat often includes a riffle area when present. Other habitats, in order of preference, include gravel, broken peat, or clay lumps in a run area; snags or logs that create a partial dam or are in run habitat; undercut banks and associated root mats; and SAV and detrital/sand areas in moving water. In riffles and most other habitats, sampling involved placing the net downstream, gently rubbing surficial substrates by hand to dislodge organisms, and disrupting deeper substrates using vigorous foot action. Each dip of the net covered one-two square feet, and a total of approximately 2.0 m^2 (20 square feet) of combined substrates was sampled; samples were preserved in 70% ethanol. Duplicate benthic samples were taken at 15 MBSS sites to assess the replicability of the field methods.

In the laboratory, the preserved sample was transferred to a gridded pan and organisms were picked from randomly selected grid cells until the cell that contained the 100th individual (if possible) was completely picked. Some samples had fewer than 100 individuals. The benthic macroinvertebrates were identified to genus, or lowest practicable taxon, in the laboratory. To aid in identification, oligochaete and chironomid taxa were slide-mounted and identified under a microscope. Laboratory QC procedures included the re-subsampling and identification of every 20th sample. This second sample was identified according to standard procedures and comparisons were made between the two duplicates. For the 2003 sampling year, samples from 15 sites were re-subsampled for QC purposes. The MBSS voucher specimen collection is currently maintained at the Maryland DNR Field Office in Annapolis, Maryland. A complete description of laboratory protocols can be found in Boward and Friedman (2000) and results of the QC analysis can be found in Rogers et al. (2004).

In macroinvertebrate monitoring, the decision to employ a particular subsample size (100 vs. 200 or greater) reflects a balance of how to best utilize program effort. While a larger subsample may improve precision in characterizing individual sites, each sample then requires additional effort for laboratory identification. If a program goal is better precision in characterizing watersheds, the added effort might be spent on a sampling more sites per watershed. At the outset of the MBSS monitoring program, a decision was made that 100-organism subsamples would provide acceptable precision at the single site level, and that, within a given total cost, effort would instead be focused on maximizing the total number of sites that could be sampled. However, DNR is interested in further investigating the effect of 100- vs. 200-organism subsampling.

2.6.4 Fish

Fish were sampled during the summer index period using double-pass electrofishing within 75-meter stream segments. Block nets were placed at each end of the segment and direct current backpack electrofishing units were used to sample the entire segment. An attempt was made to thoroughly fish each segment on each pass, sampling all habitat within the entire stream segment. A consistent effort was applied over the two passes. This sampling approach allowed calculation of several metrics constituting the biological index and produced estimates of fish species abundance.

In small streams, a single electrofishing unit was used. In larger streams, two or more were employed to effectively sample the site. Captured fish from each pass were identified to species, weighed in aggregate, counted, and released. Any individuals that could not be identified to species were retained for laboratory confirmation, and a voucher series of about 10 individuals was retained for each major (Maryland 6-digit) drainage basin. For each pass, all individuals of each gamefish species (defined as trout, bass, walleye, northern pike, chain pickerel, and striped bass) were measured for total length. For each species, unusual occurrences of visible external pathologies or anomalies were noted.

All voucher specimens and fish retained for positive identification in the laboratory were examined and verified by Dr. Rich Raesley, an ichthyologist at Frostburg State University, Frostburg, Maryland. All MBSS collections are archived in the fish museum at Frostburg State University.

2.6.5 Amphibians and Reptiles

At each segment sampled during the summer, amphibians and reptiles found during the course of electrofishing and other activities were captured, identified, and recorded. Individuals were identified to species when possible, but larval salamanders and tadpoles were not retained. Voucher specimens and individuals not positively identifiable in the field were retained for examination in the laboratory.

2.6.6 Mussels

During the summer index period, freshwater mussels were sampled by visual inspection at each 75-meter stream segment. The presence of Unionid mussels or Asiatic clam (*Corbicula fluminea*) was recorded as live, old shell, or recent shell. Mussels were identified to species.

2.6.7 Aquatic and Streamside Vegetation

During the summer index period, aquatic vegetation was sampled qualitatively by examining each 75-meter stream segment for the presence of aquatic plants. The presence and relative abundance of submerged, emergent, and floating aquatic vegetation were recorded.

In addition, the presence and relative abundance of invasive terrestrial plant species (e.g., multiflora rose) were recorded during summer sampling.

2.6.8 Physical Habitat

Habitat assessments were conducted during summer sampling at all stream segments as a means of assessing the importance of physical habitat to the biological integrity and fishability of freshwater streams in Maryland. Procedures for habitat assessment (Kazyak 2001) were derived from two commonly used methodologies: EPA's Rapid Bioassessment Protocols (RBPs) (Plafkin et al. 1989), as modified by Barbour and Stribling (1991), and the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) (Ohio EPA 1987, Rankin 1989).

During spring, riparian zone vegetation type and width on each bank was estimated to the nearest meter (up to 50 meters from stream). Severity and type of buffer breaks were noted. Local land use type and the extent and type of stream channelization were recorded and stream gradient was measured. Crews also recorded distance from the nearest road and assigned a trash rating (based on visible signs of human refuse at a site) to characterize human presence.

During summer sampling, several habitat characteristics (instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, and riffle/run quality) were assessed qualitatively on a 0-20 scale, based on visual observations within each segment. The percentage of embededdness of the stream channel and the percentage of shading of the stream site were estimated. Also recorded were the extent and severity of bank erosion and bar formation, number of woody debris and rootwads within the stream channel, and the presence of various stream features such as substrate types, various morphological characteristics, and beaver ponds. Maximum depth within the segment was measured. Wetted width, thalweg depth, and thalweg velocity were recorded at four transects. A complete velocity/depth profile was taken at one transect to compute discharge (streamflow); for sites with extremely low flow, the speed of a floating object was substituted to allow calculation of discharge.

Recognizing that water temperature is an important factor affecting stream condition (but one that varies daily and seasonally), the Survey deployed temperature loggers at most sites. A single Onset Computer Corporation Optic Stowaway model temperature logger was anchored in each sample site during the summer index period. They recorded the water temperature every 20 minutes from approximately June 1 until September 1. Field crews had the option of retrieving the loggers during summer sampling if the site was visited after August 15. In some cases, the same logger was used for two sites if they were close together on the same reach. Also, if a site was nearly dry in the spring, field crews may have elected not to deploy a logger.

2.7 BIOLOGICAL INDICATORS

The Index of Biotic Integrity (IBI) is a stream assessment tool that evaluates biological integrity based on characteristics of the fish or benthic assemblage at a site. Biological integrity is defined as

> *the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region.*
>
> -- Karr and Dudley (1981) as cited in Karr (1991)

To develop an IBI, reference sites are selected to represent regional natural habitats, also referred to as "minimally impacted" conditions. We recognize that no streams in Maryland are entirely undisturbed by human activities. Atmospheric deposition of contaminants alone reaches all parts of the State, few streams have natural temperature regimes, and more than 1,000 man-made barriers to fish migration have been documented in Maryland. Therefore, reference conditions currently in use should not be viewed as completely natural or pristine.

They are, however, a representative sample of the best streams that currently exist in the State. Whether these conditions are the best attainable depends on future restoration activities and the goals of DNR, other agencies, and the public.

Sites were evaluated using both the fish and benthic IBIs developed for the MBSS, indicators previously employed in evaluating Round One results (Roth et al. 1999). For details about IBI development, see Roth et al. (2000) and Stribling et al. (1998). IBI scores for each site were determined by comparing the fish or benthic assemblage to those found at minimally impacted reference sites. Three separate formulations were employed for the fish IBI, one for each of three distinct geographic areas: Coastal Plain, Eastern Piedmont, and Highlands. Two different formulations of the benthic IBI were used in the Coastal Plain and non-Coastal Plain regions. IBIs were calibrated specifically for each ecological region during their development.

The MBSS computes the IBI as the average of individual metric scores. Individual metric scores are based on comparison with the distribution of metric values at reference sites within each geographic stratum. Metrics are scored 1 (if < 10th percentile of reference value), 3 (10th to 50th percentile), or 5 ($\geq$ 50th percentile). The final IBI scores are calculated as the average of three scores and therefore range from 1 to 5. An IBI $\geq$ 3 indicates the presence of a biological community with attributes (metric values) comparable to those of reference sites, while an IBI < 3 means that, an average, metric values fall short of reference expectations. Table 2-8 contains narrative descriptions for each of the IBI categories developed for the Survey.

Because an IBI score of 3 represents the threshold of reference condition, values less than 3 (i.e., poor or very

Table 2-8. Narrative descriptions of stream biological integrity associated with each of the IBI categories		
Good	IBI score 4.0 - 5.0	Comparable to reference streams considered to be minimally impacted. On average, biological metrics fall within the upper 50% of reference site conditions.
Fair	IBI score 3.0 - 3.9	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally impacted streams. On average, biological metrics fall within the lower portion of the range of reference sites (10th to 50th percentile).
Poor	IBI score 2.0 - 2.9	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating degradation. On average, biological metrics fall below the 10th percentile of reference site values.
Very Poor	IBI score 1.0 - 1.9	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of these minimally impacted streams, indicating severe degradation. On average, biological metrics fall below the 10th percentile of reference site values; most or all metrics are below this level.

poor) represent sites suspected to be degraded. In contrast, values greater than or equal to 3 (i.e., fair or good) indicate that most attributes of the community are within the range of those at reference sites. Highest scores (IBI of 4 to 5) were designated as good, recognizing that available reference sites do not necessarily represent the highest attainable condition nor are these sites pristine or completely natural. The assignment of scores to narrative categories is a useful method for translating scores into a form that is easily communicated.

2.8 QUALITY ASSURANCE

Quality assurance and quality control (QA/QC) are integral parts of the data collection and management activities of the Survey. The Survey employs well-established QA/QC procedures, as detailed in Kazyak (2001). Some key points are highlighted below.

2.8.1 Data Management

All crews used standardized pre-printed data forms developed for the Survey to ensure that all data for each sampling segment were recorded and standard units of measure were used. Using standard data forms facilitates data entry and minimizes transcription error. The field crew leader and a second reviewer checked all data sheets for completeness and legibility before leaving each sampling location. Original data sheets were sent to the Data Management Officer for further review, another signoff, and data entry, while copies were retained by the field crews.

A custom database application (written in Microsoft Access), in which the input module was designed to match each of the field data sheets, was used for data entry. Data were independently entered into two databases and compared using a computer program as a quality-control procedure. Differences between the two databases were resolved from original data sheets and, where appropriate, through discussions with field crew leaders.

2.8.2 QA/QC for Field Sampling

A Quality Control Officer (QC Officer) experienced in all aspects of the Survey was appointed to administer the quality assurance program. Specific quality assurance activities administered by the QC Officer included preparing a field manual of standard sampling protocols, designing standard forms for recording field data, conducting field crew training and proficiency examinations, conducting field and laboratory audits, making independent habitat assessments, identifying taxa, reviewing all reports, and reporting errors.

To ensure consistent implementation of sampling procedures and a high level of technical competency experienced field biologists were assigned to each crew and all field personnel completed program training before participating in field sampling. Training topics included MBSS program orientation, stream segment location using global positioning system (GPS) equipment, sampling protocols, operation and maintenance of sampling equipment, data transcription, quality assurance/quality control, and safety. The spring field crews received additional training in sampling protocols for water quality and benthic macroinvertebrates. The summer field crews received additional training in habitat assessment methods, taxonomy, and *in situ* water chemistry assessment.

Training included classroom, laboratory, and field activities. Instructors emphasized the objectives of the Survey and the importance of strict adherence to the sampling protocols. The QC Officer conducted proficiency examinations to evaluate the effectiveness of the training program and ensure that the participants had detailed knowledge of the sampling protocols. Members of the spring sampling crew were required to demonstrate proficiency in techniques for collecting samples for water chemistry and benthic macroinvertebrates. At least one member of each summer sampling crew was required to pass a comprehensive fish taxonomy examination. Each crew also demonstrated proficiency in locating preselected stream segments using the GPS receiver and determining if the segment was acceptable for sampling. Comprehensive "dry runs" were conducted to simulate actual field conditions and evaluate classroom instruction.

Field audits were conducted by the QC Officer during the field sampling to assess the adequacy of training, adherence to sampling protocols, and accuracy of data transcription. The audits included evaluation of the preparation and planning prior to field sampling, stream segment location using GPS equipment and assessment of acceptability for sampling, adherence to sampling protocols, data transcription, and equipment maintenance and calibration. The QC Officer made an independent assessment of habitat at all segments where field audits were done (approximately 13% of the total number of sites).

A separate QA report (Rogers et al. 2004) reports on details of QA activities for the 2003 sampling year.

2.9 CLIMATIC CONDITIONS

Because all flow in Maryland streams ultimately arises from precipitation, weather is an important factor in stream condition. In Maryland, annual precipitation varies geographically, averaging between 40 and 50 inches. In the western half of the state, the prevailing winds are from the west, typically mixing moisture from the south with colder temperatures from the north. Because of these prevailing winds and Maryland's mountain ridges (which create a rainshadow effect), rain and snowfall are greater in the west and precipitation tends to be heavier on west-facing slopes. In the eastern half of the state, prevailing winds are also westerly, but many storm events are also influenced by moisture from the coast and precipitation patterns there reflect that influence. These precipitation patterns have an obvious effect on runoff, a primary factor in determining stream characteristics. Because the flow of water (stream discharge) is one of the critical determinants of stream habitat quantity and quality, drier portions of the state should have less aquatic habitat than areas that are wetter.

Temporal changes in the amount of precipitation are also important in determining the amount of habitat available to aquatic organisms. Figures 2-3 through 2-7 show the monthly deviation from normal precipitation (in inches) for the years 1998-2003 (NOAA 1998, NOAA 1999, NOAA 2001, and NOAA 2002, NOAA 2003). This number is the average of the deviation from normal precipitation (calculated using 100 years of precipitation data) in eight regions of the state, so it is possible that some effects seen only in the eastern portion of the state may be masked by events in the western portion of the state and vice versa. Actual monthly values for each region are shown in Appendix A.

Beginning in 1998, precipitation was lower than normal in Maryland. In 2002, drought conditions worsened (Figure 2-7), leading the governor to declare a drought emergency. The City of Baltimore experienced the driest February, amid the fourth-driest winter, since record-keeping began in 1871. By the end of February, water levels in Baltimore's reservoirs dipped below the lows reached during the drought of 1999. Mandatory restrictions on water consumption were imposed throughout the state. By August of 2002, the driest September to mid-August period in Baltimore was recorded since 1871. In the year from September 2000 to September 2001, Baltimore-Washington International Airport recorded 23.86 inches of precipitation, less than 57% of normal for the period and a deficit of more than 18 inches. Less than an inch of rainfall was recorded at the airport between July 27, 2002 and August 21, 2002. Conditions began to improve as Maryland recorded the wettest October in seven years – as much as 6 inches of rain was recorded in parts of Central Maryland. Wetter than normal conditions in November and December of 2002, also contributed to the end of the drought emergency in Maryland.

As a result of this period of low precipitation culminating in severe drought during 2002, it was expected that the abundance of fish and other aquatic organisms would be lower in 2003 than previous years.

However, Sentinel Site CBI scores were not consistently low due to the drought and low flow conditions. At the same time, the drought did negatively impact a few sites in the Coastal Plain physiographic province. CORS-102-S-2002 and WCHE-086-S-2002 both went dry in the summer of 2002. In addition, MATT-033-S-2002 consisted only of a few standing pools and had the lowest FIBI score in the four years that it has been sampled. This illustrates that although the drought was widespread, only certain watersheds appeared to be adversely impacted during the drought.

In the future, the Survey will consider adjusting individual site fish and benthic IBI scores relative to the scores obtained at the Sentinel Sites. By the spring of 2003, rainfall had recovered from drought conditions. In fact, 2003 was a very wet year, as reflected in Figure 2-8.

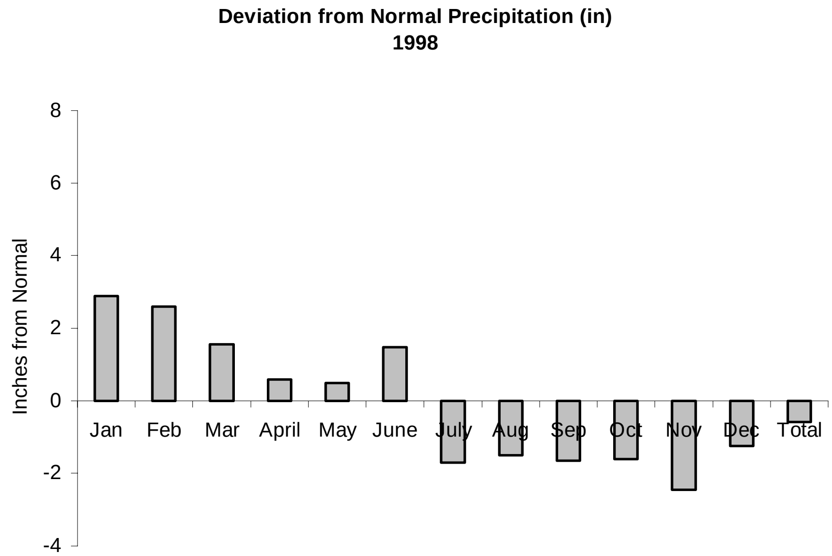

Figure 2-3. Statewide average deviation from normal precipitation during 1998

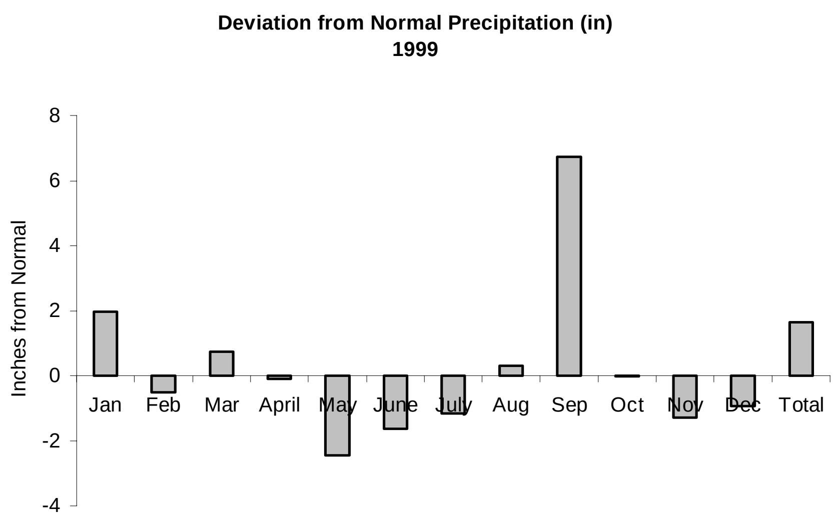

Figure 2-4. Statewide average deviation from normal precipitation during 1999

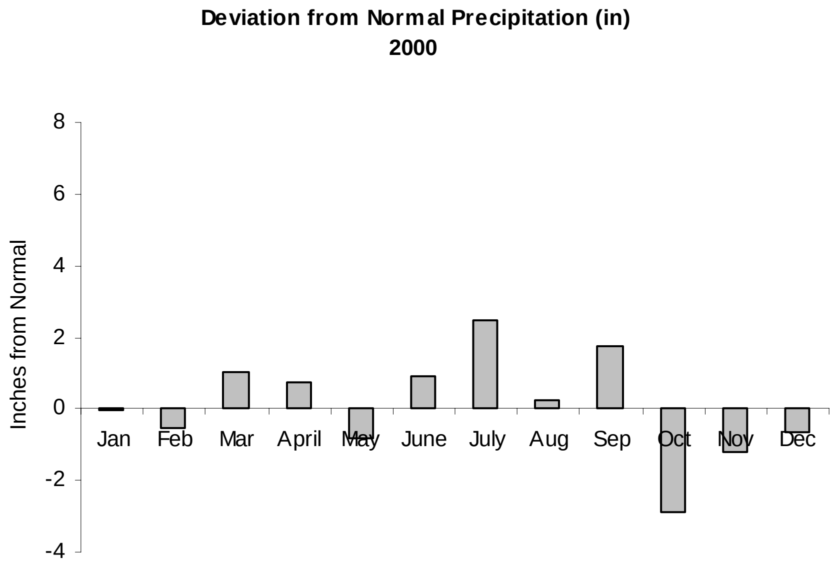

Figure 2-5. Statewide average deviation from normal precipitation during 2000

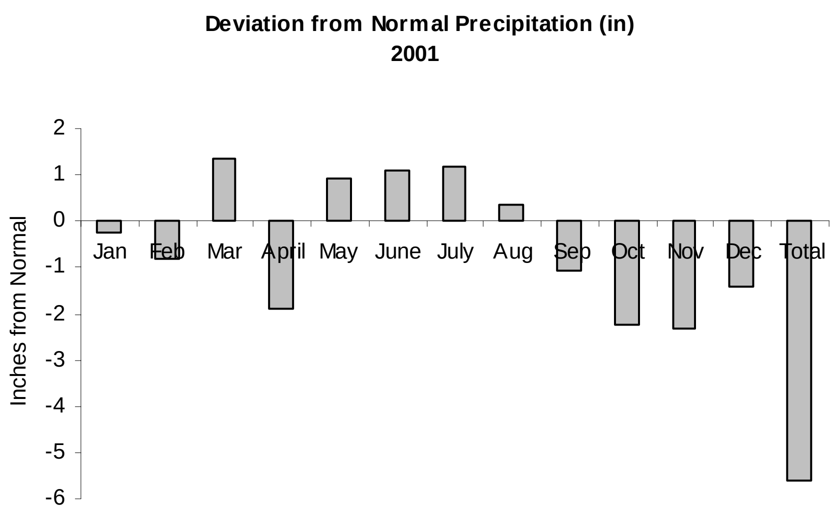

Figure 2-6. Statewide average deviation from normal precipitation during 2001

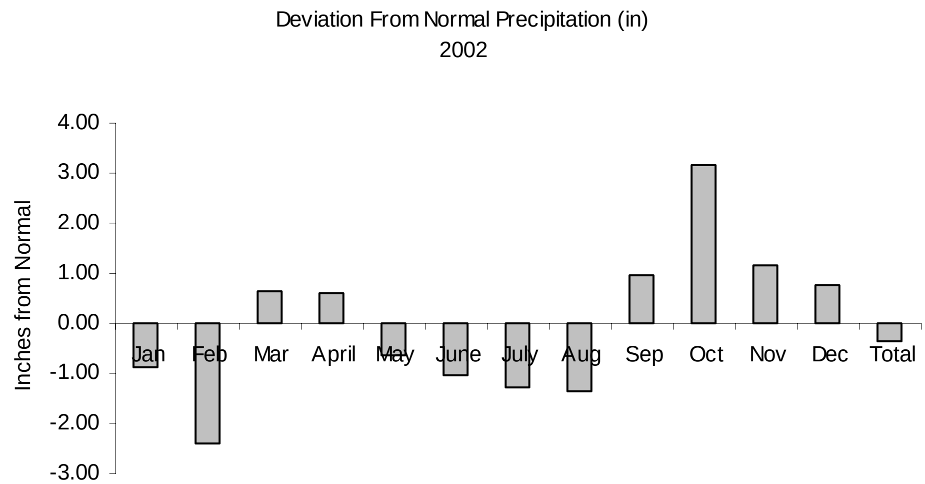

Figure 2-7. Statewide average deviation from normal precipitation during 2002

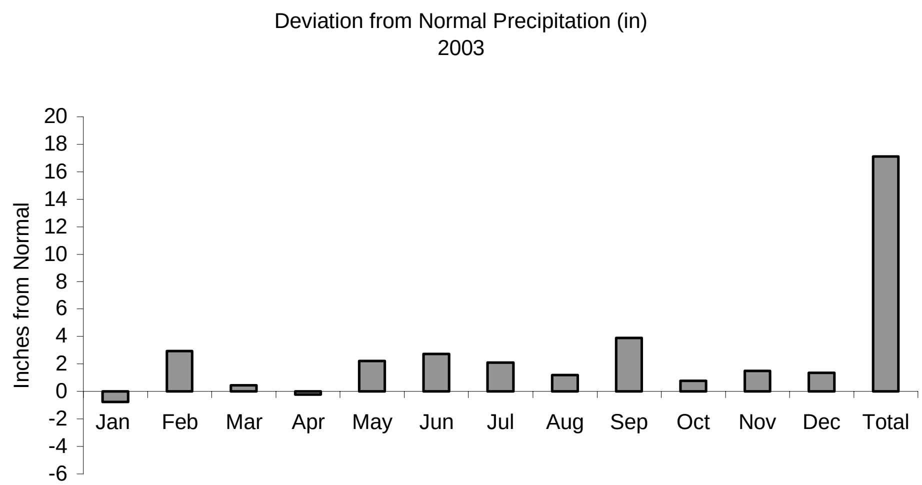

Figure 2-8. Statewide average deviation from normal precipitation during 2003

With the exception of January, March, and April, all monthly rainfall amounts were greater than normal. Hurricane Isabel made landfall in Maryland in September 2003, dumping large amounts of rain on the region. Increased rainfall amounts and the proceeding drought recovering are reflected in flow data from 2003 MBSS Sentinel Sites.

3 THE STATE OF THE STREAMS: COMPARATIVE ASSESSMENT OF WATERSHEDS SAMPLED IN 2003

This chapter provides a comparative assessment of the watersheds (PSUs) sampled by the MBSS (or Survey) in 2003. Separate sections focus on biodiversity, biological indicator results, and three predominant issues affecting biological resources: acidification, physical habitat, and nutrients and other water chemistry. The indicators used were developed during Round One of the MBSS and have been deemed reliable for representing ecological condition by field verification and expert peer review. Nonetheless, the MBSS continues to pursue refinements to its indicators, including improvements to the provisional physical habitat index (PHI), methods for combining indicators that do not lose information (e.g., combined biotic index), and changes to the indicator thresholds and scoring methods to make them more intuitive and accessible to the public.

3.1 BIODIVERSITY

In addition to assessing the integrity of streams and watersheds, the Survey provides invaluable information on the abundance and distribution of rare species. Documenting the presence (and ultimately abundance in the five-year Round Two volumes) of rare species, the Survey supports a more thorough characterization of Maryland's aquatic biodiversity. During MBSS sampling in 2003, a substantial number of rare or unusual occurrences of fish were documented. This chapter presents a brief summary of particularly noteworthy findings. Two state-listed “rare” species were observed at MBSS sites in 2003 (including Sentinel sites): flier (*Centrarchus macropterus*) and pearl dace (*Margariscus margarita*). Three state-listed “rare” species were also observed: banded sunfish (*Enneacanthus obesus*), mud sunfish (*Ancantharchus pomotis*), and longnose gar (*Lepisosteus osseus*). Five other species observed in 2003 are on the state watch list: bluespotted sunfish (*Enneacanthus gloriosus*), mottled sculpin (*Cottus bairdi*), shield darter (*Percina peltata*), warmouth (*Lepomis gulosus*) and brook trout (*Savelinus fontinalis*). Complete taxa lists of fish, benthic macroinvertebrates, amphibians, and reptiles observed in each PSU are included in Chapter 4 of this report.

Five fliers were found at two sites in St. Mary’s River. A total of 365 pearl dace were found at five sites in Antietam Creek (359 individuals were found at one site alone). Forty-one banded sunfish were found at five sites in the Honga River PSU (2 individuals), Pocomoke Sound PSU (3 individuals), and Dividing Creek/Nassawango Creek (36 individuals at two Sentinel sites). Nine mud sunfish were found at two sites in the Pocomoke Sound PSU and at one Sentinel site in Dividing Creek/ Nassawango Creek. One longnose gar was found at a Sentinel site in Mattawoman Creek. A total of 415 bluespotted sunfish were found at: 10 sites in Little Elk Creek PSU (17 individuals), Pocomoke Sound PSU (98 individuals), Middle Chester River (10 individuals), Dividing Creek/Nassawango Creek (four individuals at one Sentinel site), and St. Mary’s River (298 individuals, 279 of which were at one site). Two-hundred and eighty-seven (287) mottled sculpin were found at one Sentinel site in the Youghiogheny River. Fourteen (14) shield darters were found at three sites in Broad Creek (12 individuals) and two sites in Little Gunpowder Falls (two individuals). One warmouth was observed at a Sentinel site in Mattawoman Creek. Finally, 264 brook trout were found at 14 sites: one site in Antietam Creek (three individuals), two sites in Georges Creek (15 individuals), two sites in Liberty Reservoir including one Sentinel site (five individuals), one Sentinel site in Loch Raven Reservoir (two individuals), one Sentinel site in Potomac River Lower North Branch (61 individuals), three Sentinel sites in Savage River (120 individuals), one site in Magothy/Severn Rivers (two individuals), two Sentinel sites in Upper Monocacy River (48 individuals), and one Sentinel site in the Youghiogheny River (eight individuals).

In addition to state-listed fish species, two species found at less than 2% of the MBSS sites sampled in Round One were also collected in 2003: rainbow darter (*Etheostoma caeruleum*) and checkered sculpin (*Cottus* sp. n). A total of 30 rainbow darters were found in two sites in Antietam Creek (11 individuals), two sites in Catoctin Creek (seven individuals), one site in the Lower Monocacy River (six individuals), and one site in the Potomac River Lower North Branch (six individuals). A total of 167 checkered sculpin were found at five sites in Antietam Creek (137 individuals at one site alone).

One Jefferson salamander, an amphibian on the state watch-list, was found at a site sampled for the National Park Service.

The sections below contain a summary of biological indicator results for MBSS core sites sampled in 2002. Included are the fish IBI, benthic IBI, and an integrated summary of both bioindicators, the Combined Biotic

Index (CBI), the average of the fish and benthic IBIs or if only one IBI exists for a site that score is used.

3.1.1 Fish IBI Results

Although a target of sampling 10 sites per PSU was set, in some cases fewer than 10 sites received fish IBI scores (Table 3-1). A total of 211 core sites in 20 PSUs were sampled for fish during summer 2003. Of these sites, 53 sites were not rated by the fish IBI, as they were very small headwater streams (each with a catchment area less than 300 acres) where expectations of fish abundance and diversity are too low for development of an effective indicator.

In addition, because the fish IBI may underrate coldwater and blackwater streams owing to their naturally low species diversity, evidence of these stream types was used as a secondary indicator in interpreting scores. Sites where brook trout were present (a clear sign of coldwater conditions) and where fish IBI scores were less than 3 were excluded from analysis and reported as "not rated This situation was rare (6 sites). Along with low species richness, naturally acidic blackwater streams may also be dominated by a few acid-tolerant species. Because of the concern for possibly underrating blackwater streams, the four blackwater streams with fish IBI scores less than 3 were excluded from analysis and were instead classified as "not rated." Blackwater streams were defined as sites with either pH < 5 or ANC < 200 μeq/l and DOC $>$ 8 mg/l. Over time, the Survey plans to build its database of coldwater and blackwater streams to the point where it can develop biological indicators particular to these special stream types.

Other factors that may affect fish IBI scores should be considered in interpreting scores for individual sites. Sites with natural features such as bedrock substrate or a small, shallow stream channel may naturally support few species.

Fish IBI scores for sites sampled in the 2003 MBSS spanned the full range of biological condition from 1.0 (very poor) to 4.56 (good). Fish IBI data for each PSU are depicted in Figure 3-1 and listed in Appendix Table B-1. Mean fish IBIs for PSUs sampled in 2000-2003 are mapped in Figure 3-2. Over the remaining year of Round Two sampling, data will be collected in remaining PSUs

Table 3-1. Number of sites electrofished in summer 2001 (by PSU), numbers of special cases, and number of sites available for fish IBI (FIBI) analysis

PSU	Number of Sites Fished	Number of Sites < 300 acres	Number of Brook Trout Sites with FIBI < 3	Number of Blackwater Sites with FIBI < 3	Number of sites Available for FIBI
Potomac River L N Br	15	4	1	0	11
Georges Creek	10	1	2	0	7
Antietam Creek	12	1	1	0	10
Lower Monocacy	20	7	0	0	13
Catoctin Creek	12	3	0	0	9
Rock Creek/Cabin John Creek	10	3	0	0	7
Liberty Reservoir	15	2	1	0	12
St. Marys River	10	4	0	0	6
Magothy/Severn Rivers	9	2	1	0	6
Port Tobacco River	10	1	0	0	9
West Chesapeake Bay	10	5	0	0	5
Little Gunpowder Falls	9	2	0	0	7
Broad Creek	10	2	0	0	8
Lower Elk River PSU	10	4	0	0	6
Miles/Wye Rivers	10	1	0	0	9
Middle Chester River	10	0	0	0	10
Honga River PSU	10	8	0	0	2
Tuckahoe Creek	9	0	0	0	9
Pocomoke Sound PSU	10	3	0	4	3
TOTAL	211	53	6	4	149

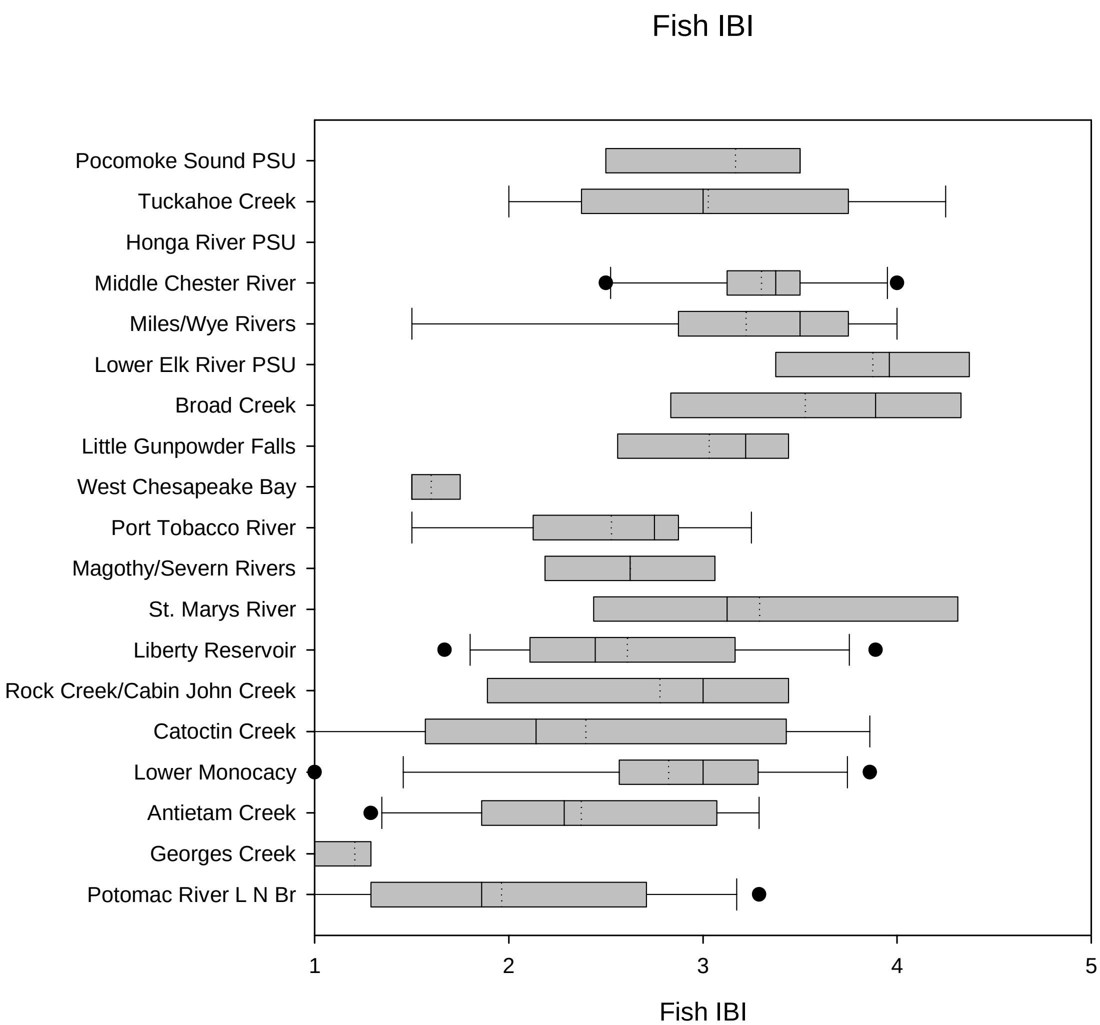

Figure 3-1. Distribution of fish Index of Biotic Integrity (IBI) scores for the MBSS PSUs sampled in 2003. The solid vertical line indicates the median value of the data, while the dotted line indicates the mean value. The grey box delineates the 25th and 75th percentiles of the data, while the whiskers indicate the 10th and 90th percentiles of the data. Dots indicate outliers.

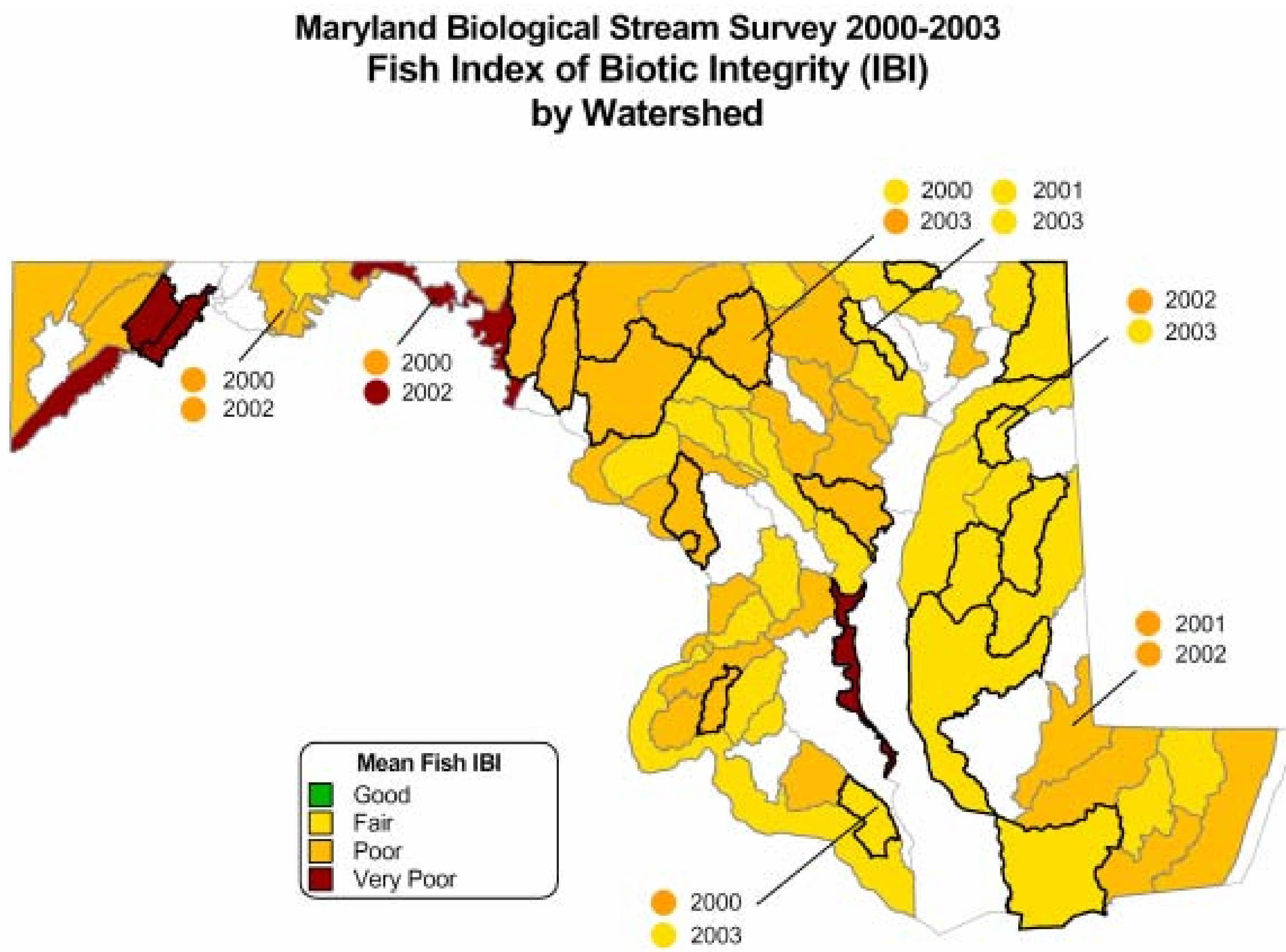

Figure 3-2. Mean fish Index of Biotic Integrity (IBI) in MBSS PSUs sampled in 2000, 2001, 2002, and 2003. PSUs sampled in 2003 have bolder outlines than those sampled in 2000-2002. Five PSUs that were sampled in previous years were also sampled in 2003.

to complete an updated statewide picture of biological conditions. Mean fish IBI by PSU ranged from 1.21 (Georges Creek) to 3.88 (Lower Elk River PSU).

Data were also used to estimate the extent of streams in poor to very poor condition within each PSU. The MBSS Round Two study design, based on simple random sampling, makes it possible to calculate an exact confidence interval around each estimate based on the binomial distribution. The extent of streams within a given condition (e.g., IBI < 3) is expressed as a percentage of all first-through fourth-order stream miles in the PSU, with an associated 90% confidence interval around the estimate. The 90% confidence interval was selected as the most appropriate for balancing the variability of the data and the need for information to support management decisions. This recognizes that requiring very high confidence can lead to an unnecessarily large number of decisions not to act.

Figure 3-3 shows the 90% confidence intervals for the percentage of stream miles with fish IBI < 3, by PSU. Values are listed in Appendix Table B-2. Results indicate Broad Creek has the least extensive occurrence of poor to very poor fish IBI scores. With 90% confidence, we can say that only 0-53% of stream miles in this PSU had poor to very poor fish IBI scores. In contrast, with 90% confidence we can say that 59 to 100% of stream miles in Georges Creek had poor to very poor fish IBI scores.

Note that the confidence intervals are most narrow where (1) conditions tend to be homogeneous (i.e., one condition occurs at all or nearly all sites, whereas the alternative condition occurs at 0 or few sites) and (2) the number of samples is high. For PSUs with small sample size, the confidence interval is, as expected, fairly wide. Completion of all Round Two sampling by 2004 will allow estimation of statewide and basin-specific conditions. At the basin level, larger sample sizes will result in much narrower confidence intervals, with precision comparable to Round One basin results.

For the first four years of Round Two sampling, the percentage of stream miles in each of four categories of Fish IBI was calculated for the entire State. Statewide, 16% (standard error 0.02) if stream miles were rated Good, 28% (standard error 0.02) of stream miles were rated Fair, 14% (standard error 0.02) of stream miles were rated Poor, 14% (standard error 0.02) of stream miles were rated Very Poor, and 28% (standard error 0.02) of stream miles were Not Rated.

A snapshot of good and bad conditions is illustrated by sites with the 10 best and 10 worst Combined Biotic Index (CBI) scores. Sites with the worst scores represented a broad range of stream problems. Significant impacts are noted at urban streams in heavily developed areas with extensive impervious surface and little or no riparian vegetation agricultural impacts were noted at several streams in southern Maryland and on the eastern shore. Channelization was common in both rural and urban streams.

10 worst sites in watersheds sampled by MBSS 2003, as rated by the Combined Biotic Index (CBI)

Stream Name	Site	Basin	PSU	CBI
UT LEE CREEK	LICK-121-R-2003	Choptank River	Little Choptank River	1.00
GEANQUAKIN CR	MANO-108-R-2003	Pocomoke River	Manokin River	1.00
MOORE BR	MANO-117-R-2003	Pocomoke River	Manokin River	1.00
WINEBRENNER RUN	GEOR-102-R-2003	North Branch Potomac River	Georges Creek	1.22
UT CORSEY CREEK	LICK-127-R-2003	Choptank River	Little Choptank River	1.29
ST MARY'S R UT5	STMA-115-R-2003	Lower Potomac River	St. Mary's River	1.29
LITTLE GUNPOWDER FALLS UT5	LIGU-113-R-2003	Gunpowder River	Little Gunpowder Falls	1.44
HUNTING CR	MILE-118-R-2003	Chester River	Miles River	1.54
PARKER CR UT1	WCHE-114-R-2003	West Chesapeake Bay	West Chesapeake Bay	1.54
WEST BR (MP) UT1	CATO-125-R-2003	Middle Potomac River	Catoctin River	1.56

Sites with the best scores were distributed across the state. As expected, many drained forested catchments less disturbed by human impacts. None had a high degree of urbanization. The relative influence of agriculture varied, but the best sites highlighted here tended to have good riparian buffer and good physical habitat, even when located in a highly agricultural catchment.

10 best sites in watersheds sampled by MBSS 2003, as rated by the Combined Biotic Index (CBI)

Stream Name	Site	Basin	PSU	CBI
MIDDLE CR (CATOCTIN)	CATO-104-R-2003	Middle Potomac River	Catoctin River	4.56
BLINKHORN CREEK	LOCK-126-R-2003	Choptank River	Lower Choptank River	4.34
BROAD CR	BROA-318-R-2003	Susquehanna River	Broad Creek	4.34
GRAMIES RUN	BELK-110-R-2003	Elk River	Big Elk Creek	4.33
JOHNS CR	STMA-208-R-2003	Lower Potomac River	St. Mary's River	4.20
JABEZ BR	SEVE-101-R-2003	West Chesapeake Bay	Severn River	4.14
ELK LICK RUN	GEOR-107-R-2003	North Branch Potomac River	Georges Creek	4.11
STAUB RUN	GEOR-114-R-2003	North Branch Potomac River	Georges Creek	4.11
MILL RUN (NO) UT2 UT1	PRLN-122-R-2003	North Branch Potomac River	Potomac River Lower North Branch	4.11
BROAD CR	BROA-306-R-2003	Susquehanna River	Broad Creek	4.11

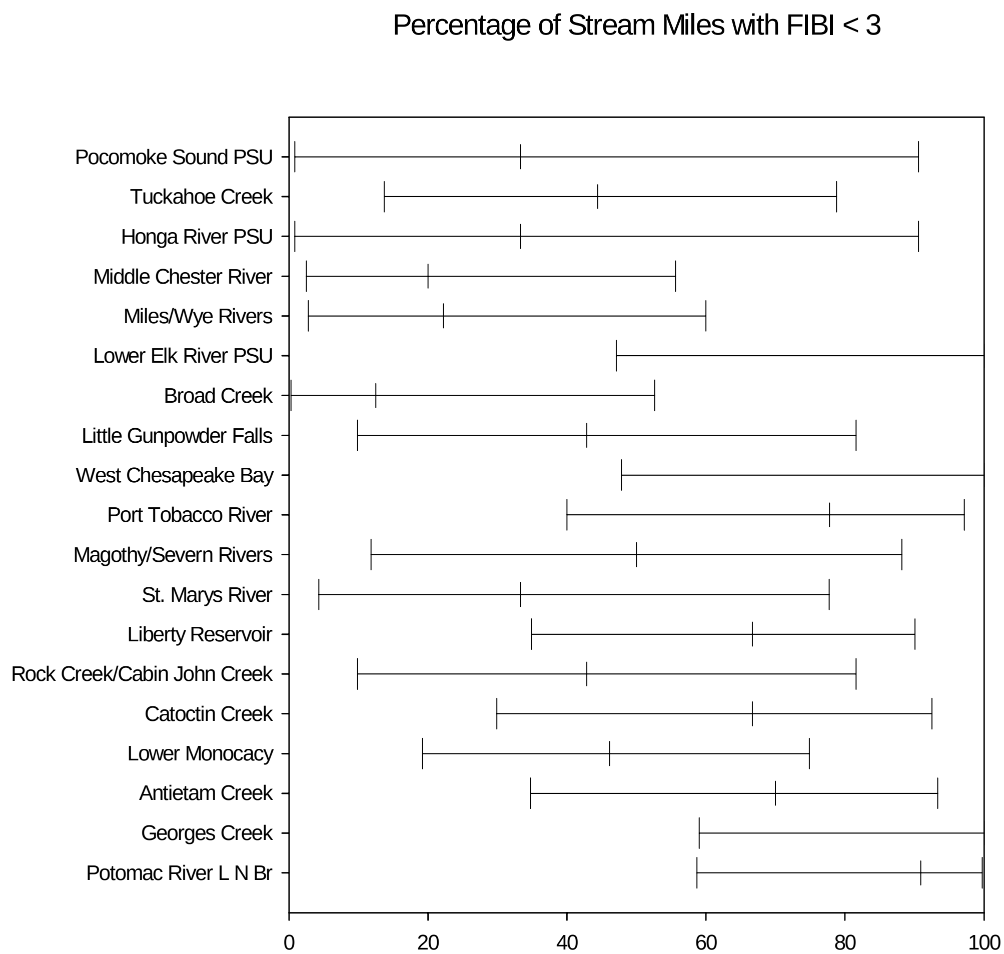

Figure 3-3. Percentage of stream miles with fish Index of Biotic Integrity (IBI) scores < 3.0 for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

3.1.2 Benthic IBI Results

Benthic IBI scores were calculated for the 211 core sites sampled in spring 2003. Scores spanned the full range of biological conditions, from 1.0 (very poor) to 5.0 (good). Benthic IBI data for each PSU are shown in Figure 3-4 and listed in Appendix B-3. Mean benthic IBIs by PSU are mapped in Figure 3-5. The lowest mean benthic IBI was 1.71 in the Pocomoke Sound PSU. The highest mean benthic IBI was 3.73 in Potomac River Lower North Branch.

The extent of occurrence of streams with benthic IBI < 3 was calculated, along with 90% confidence intervals. Values are listed in Appendix Table 3-4. As shown in Figure 3-6, an estimated 56 to 100% of stream miles in the Pocomoke Sound PSU had benthic IBI < 3. In contrast, an estimated 28 to 40% of stream miles in the Potomac River Lower North Branch had benthic IBI < 3.

Statewide, 22% (standard error 0.02) of stream miles were rated with Good BIBI scores, 34% (standard error 0.02) were rated Fair, 25% (standard error 0.02) were rated Poor, and 14% (standard error 0.02) were rated Very Poor.

3.1.3 Combined Biotic Index Results

To integrate the results of fish and benthic IBI assessments, a Combined Biotic Index (CBI) was assigned to each site. If both IBI scores were available for a site, the CBI was calculated as the mean of the fish and benthic IBI values. If only one score was available (e.g., benthic IBI but no fish IBI), the single score was assigned as the CBI. Interpretation of the CBI scores follows the guidelines in Table 3-1.

CBI scores from core MBSS sites ranged from 1.00 (very poor) to 5.00 (good). CBI data for each PSU are depicted in Figure 3-7 and listed in Appendix Table B-5. Mean CBI values by PSU are mapped in Figure 3-8. Mean CBI per PSU ranged from 1.84 (Pocomoke Sound PSU) to 3.39 (Broad Creek). The 90% confidence intervals for percentage of stream miles with CBI < 3 are shown in Figure 3-9 and Appendix Table B-6.

Statewide, 14% (standard error 0.02) of stream miles were rated with Good CBI scores, 41% (standard error 0.02) were rated Fair, 28% (standard error 0.03) were rated Poor, and 17% (standard error 0.02) were rated Very Poor.

3.2 ACIDIFICATION

The effects of acidic deposition and acid mine drainage (AMD) on stream chemistry are well documented. Maryland's 1987 Synoptic Stream Chemistry Survey (MSSCS; Knapp et al. 1988) concluded that approximately one-third of all headwater streams in Maryland are sensitive to acidification or are already acidic. Acidification is known to cause declines in both the diversity and abundance of aquatic biota. Round One MBSS results (Roth et al. 1999) and an assessment of these results in comparison with critical loads (Miller et al. 1998) confirmed that stream acidification remains a problem in Maryland freshwater streams.

The defining characteristics of surface waters sensitive to acidification are low to moderate pH and acid neutralizing capacity (ANC). pH is a measure of the acid balance of a stream. The pH scale ranges from 0 to 14, with pH 7 as neutral and pH < 7 signifying acidic conditions. Biological effects are often noted at pH < 5 or 6, except in naturally acidic systems where aquatic biota can tolerate low pH. ANC is a measure of the capacity of dissolved constituents in the water to react with a neutralized acid and is used as an index of the sensitivity of surface water to acidification. The higher the ANC, the more acid a system can assimilate before experiencing a decrease in pH. Repeated additions of acidic materials can cause a decrease in ANC. In many acidic deposition studies (e.g., Schindler 1988), an ANC of 200 µeq/L is considered the threshold for defining sensitive streams and lakes.

By measuring pH, ANC, and several analytes indicative of potential acidification sources (e.g., sulfate, nitrate nitrogen, dissolved organic carbon (DOC), and agricultural land use), the Survey provides an opportunity to examine the current extent and distribution of stream acidification in Maryland watersheds. Results from the 2003 MBSS sampling are presented below.

3.2.1 Low pH

During spring 2003 sampling, sites in three of 20 PSUs sampled exhibited pH < 5. Sites in 10 PSUs had pH < 6. Two PSUs sampled had a mean pH < 6 during spring sampling – Honga River PSU and Pocomoke Sound PSU. Spring pH values by PSU are shown in Figure 3-10. Spring pH values of individual sites are depicted in Figure 3-11. Typically, spring pH values are slightly lower than summer because of episodic acidification from spring rain events. As expected, pH tended to be slightly higher in most PSUs during the summer.

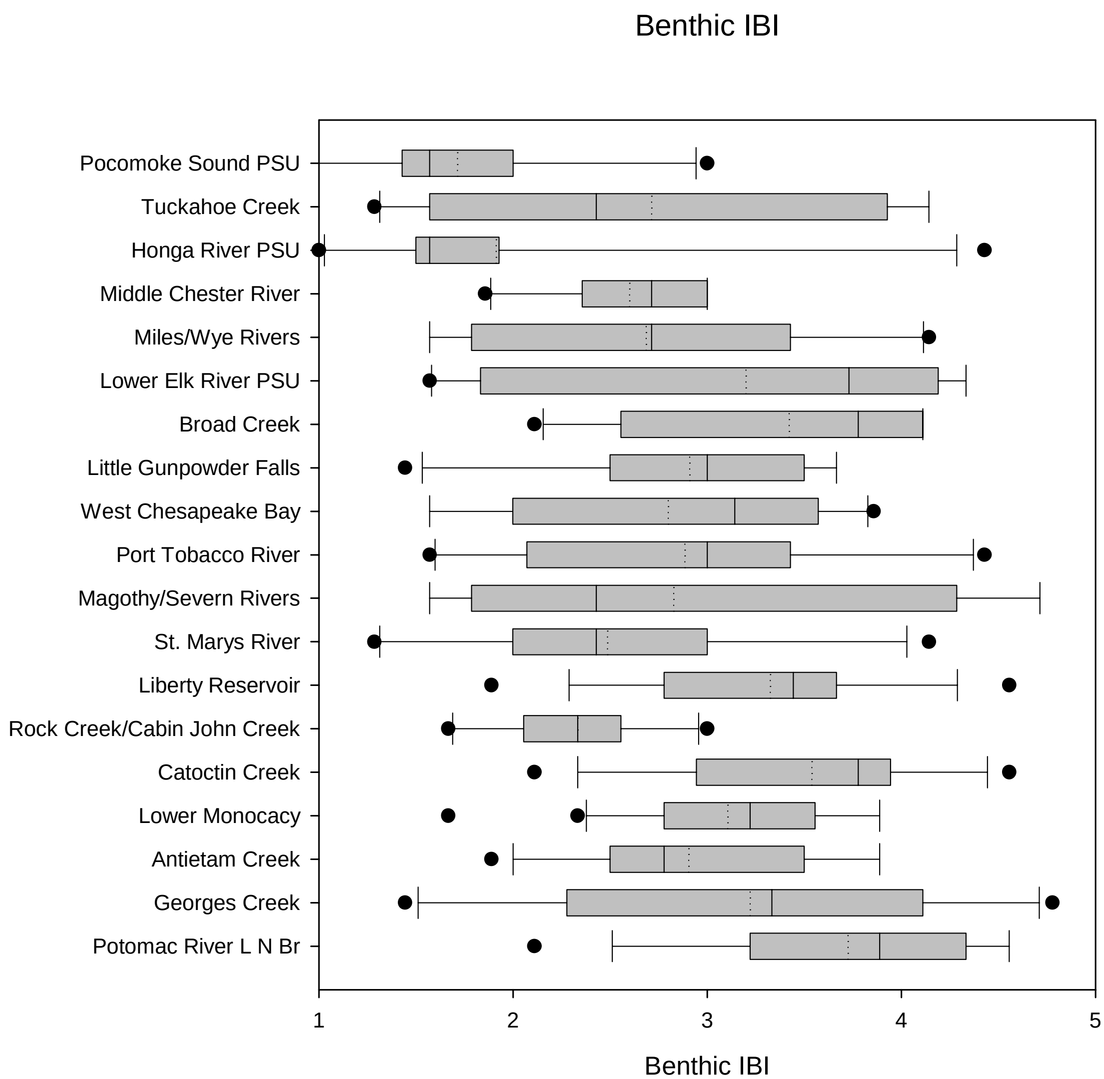

Figure 3-4. Distribution of benthic Index of Biotic Integrity (IBI) scores for the MBSS PSUs sampled in 2003

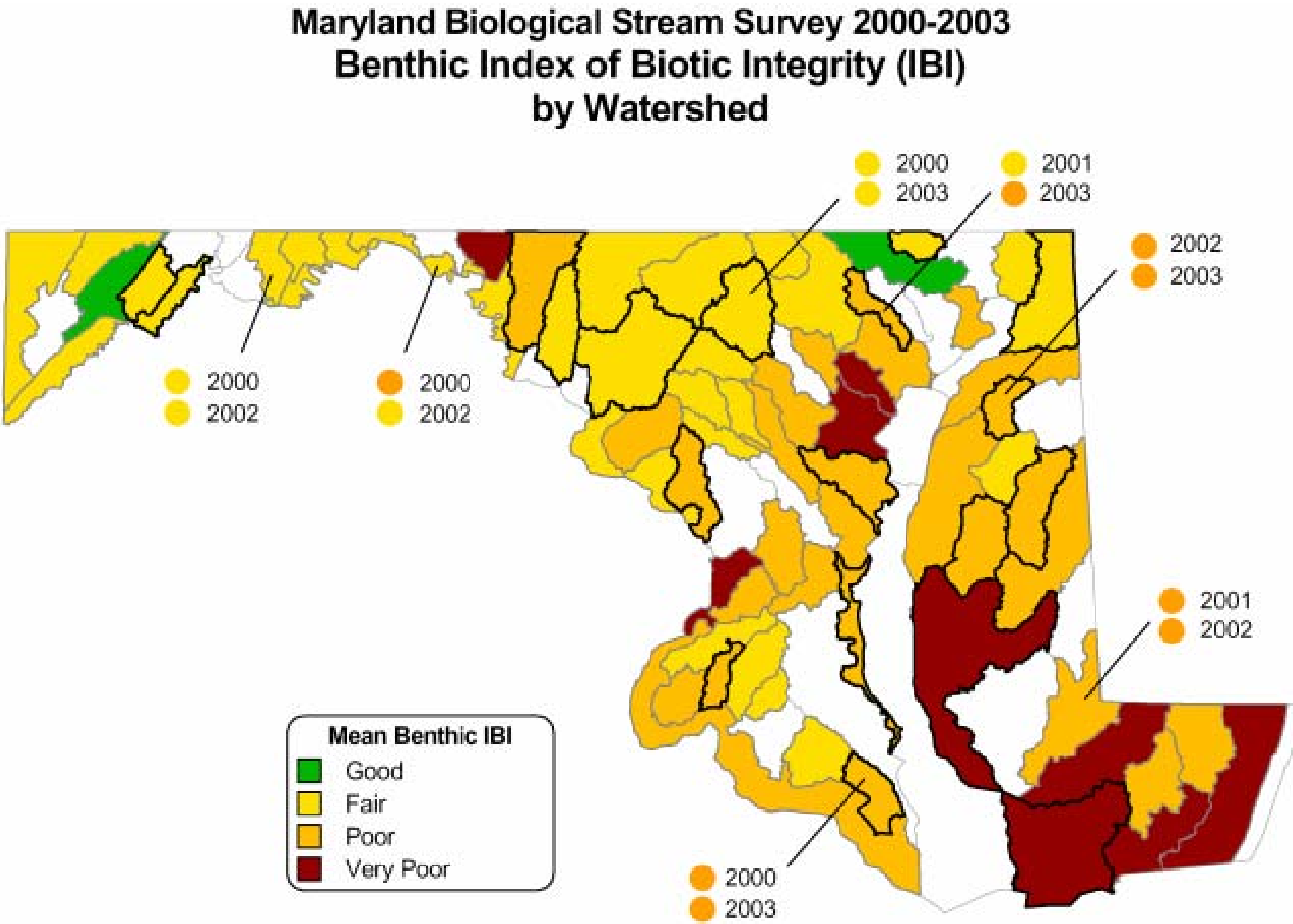

Figure 3-5. Mean benthic Index of Biotic Integrity (IBI) in MBSS PSUs sampled in 2000, 2001, 2002, and 2003. PSUs sampled in 2003 have bolder outlines than those sampled in 2000-2002. Five PSUs that were sampled in previous years were also sampled in 2003.

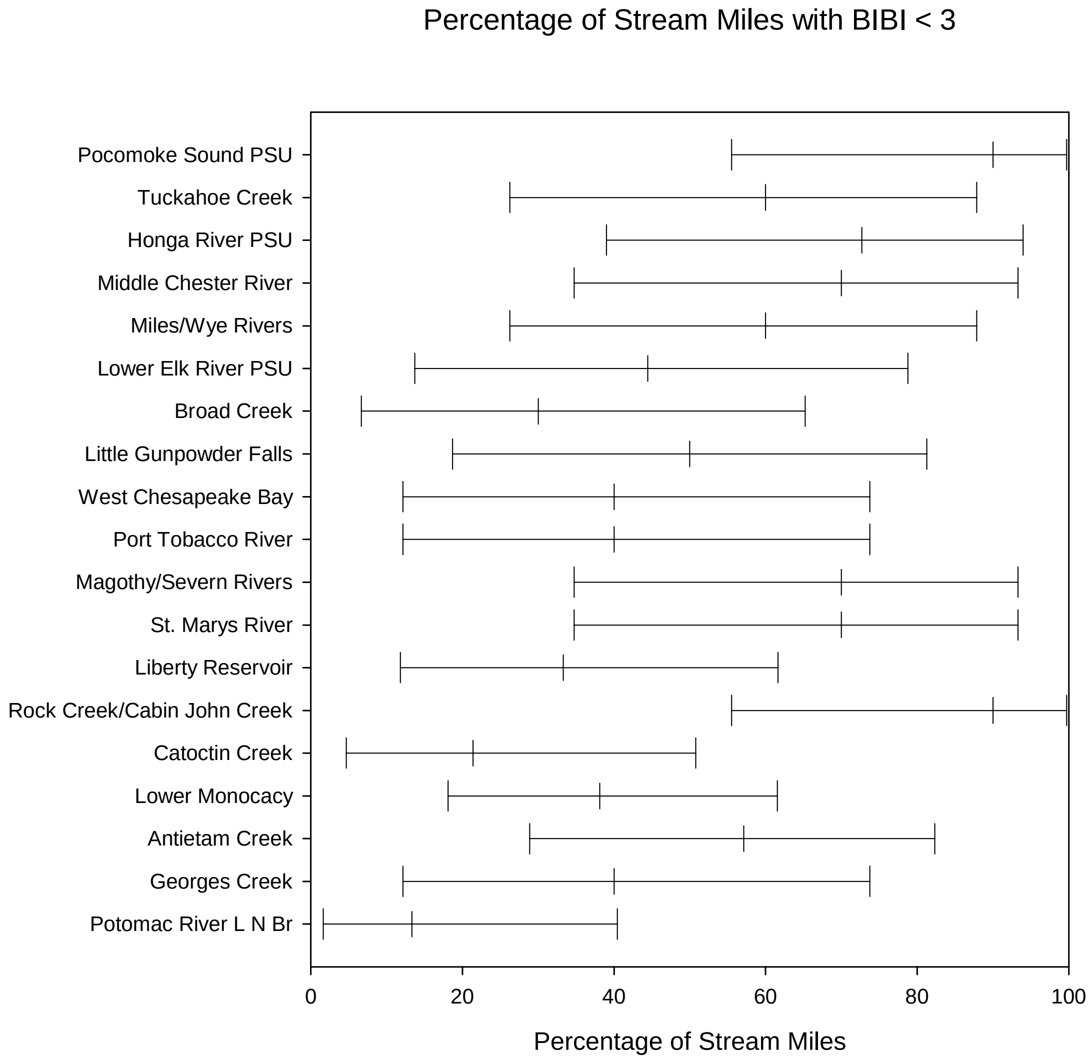

Figure 3-6. Percentage of stream miles with benthic Index of Biotic Integrity (IBI) scores < 3.0 for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

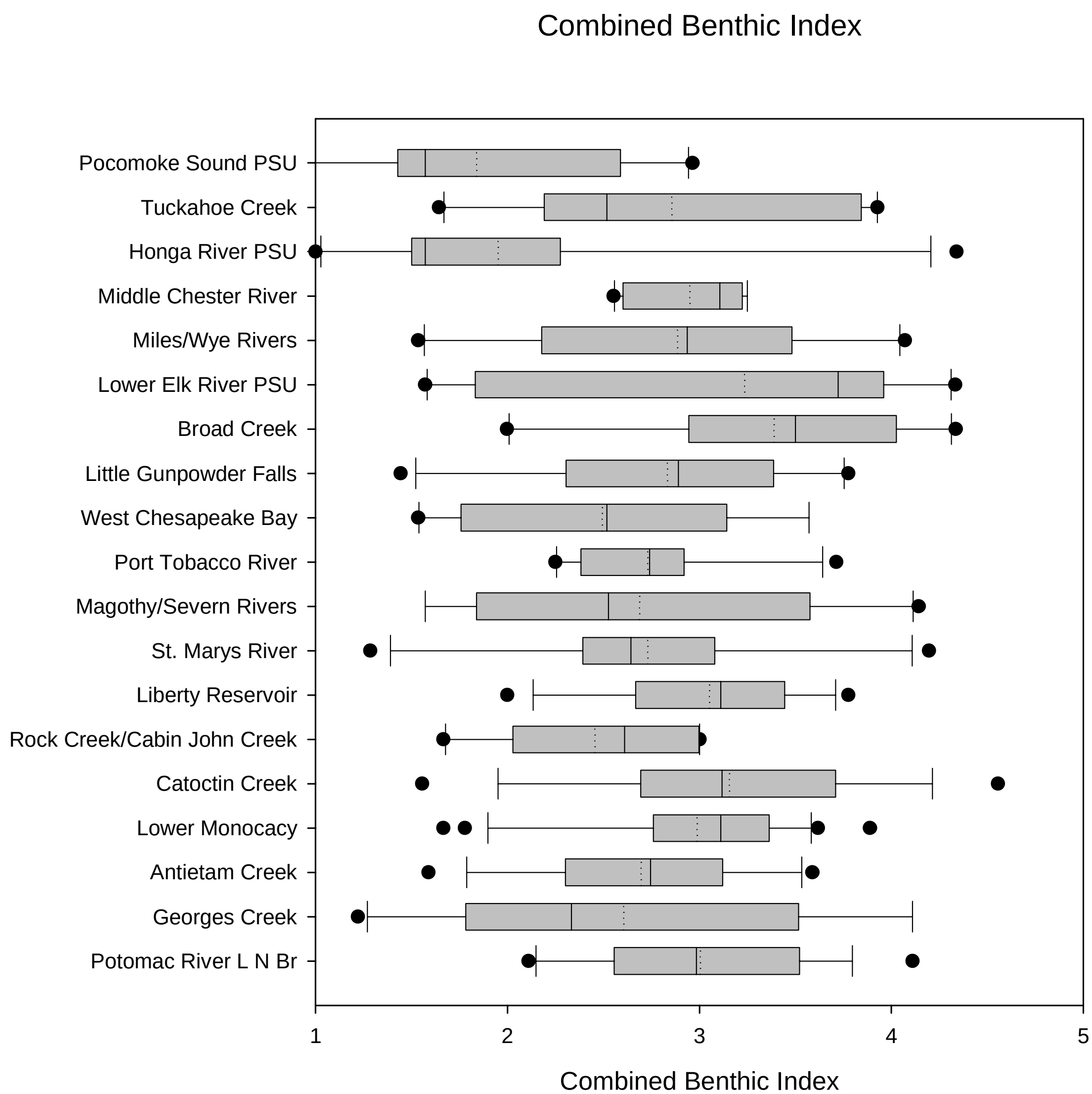

Figure 3-7. Distribution of the Combined Index of Biotic Integrity (CBI) scores for the MBSS PSUs sampled in 2003

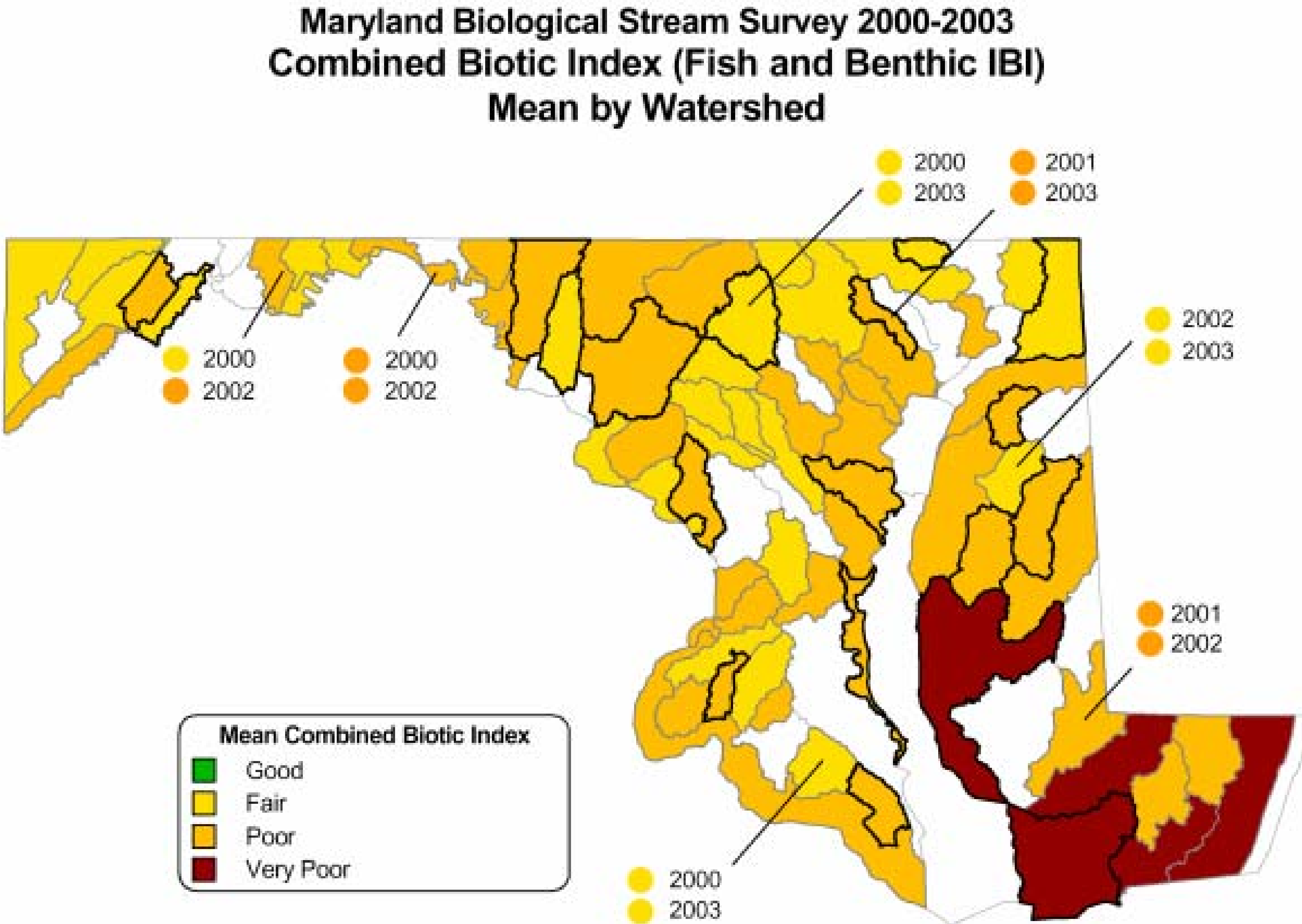

Figure 3-8. Mean Combined Biotic Index (CBI) in MBSS PSUs sampled in 2000, 2001, 2002, and 2003. PSUs sampled in 2003 have bolder outlines than those sampled in 2000-2002. Five PSUs that were sampled in previous years were also sampled in 2003.

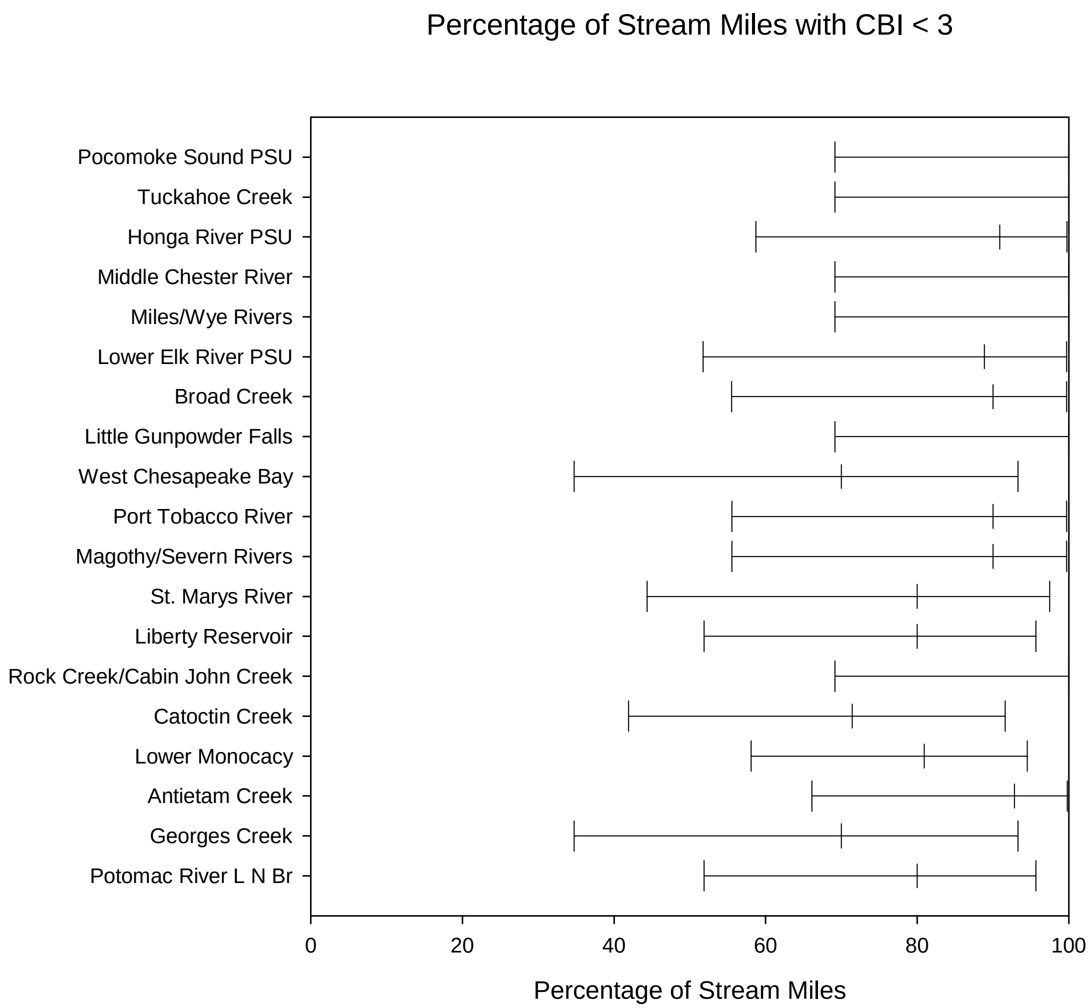

Figure 3-9. Percentage of stream miles with Combined Index of Biotic Integrity (CBI) scores < 3.0 for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

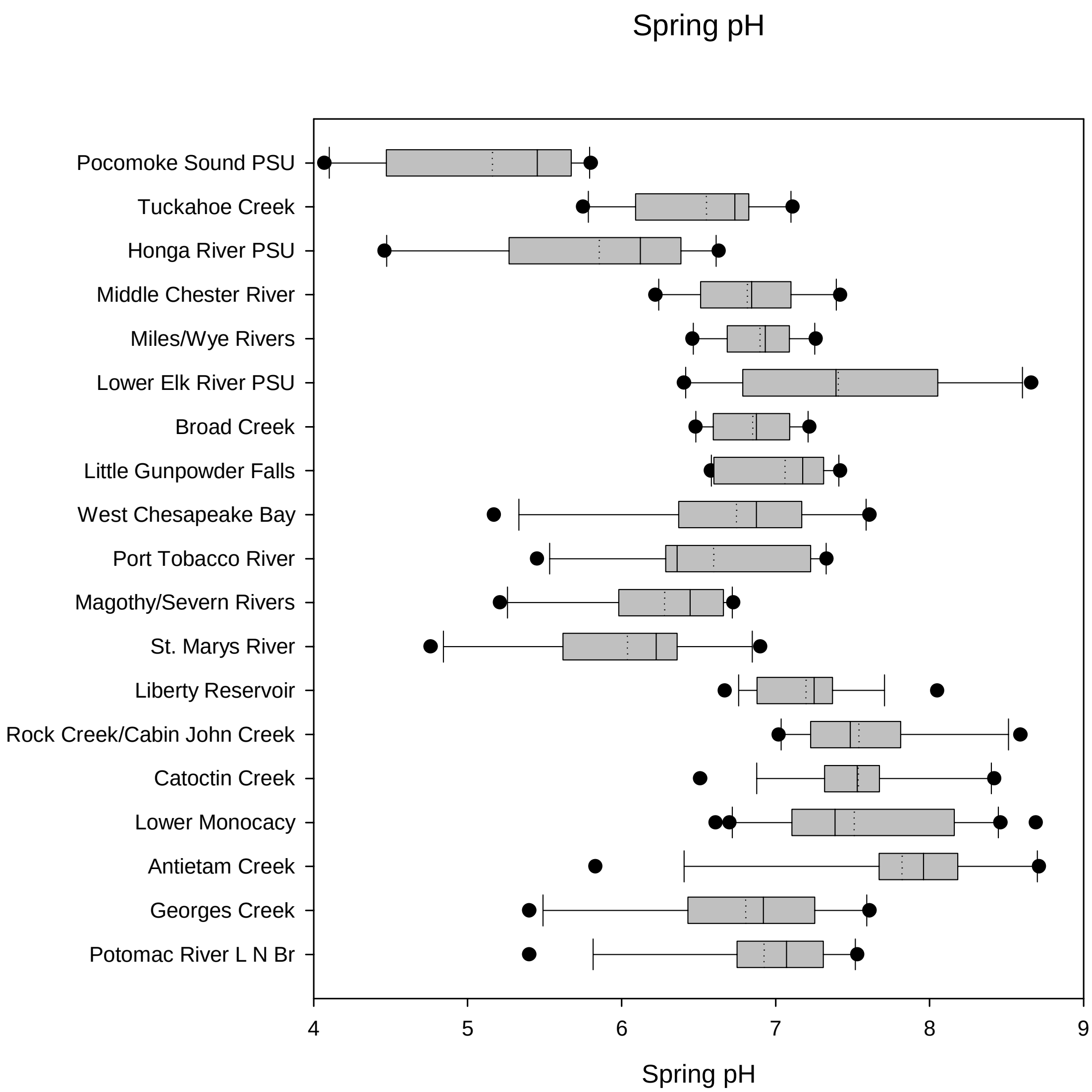

Figure 3-10. Distribution of spring pH values for the MBSS PSUs sampled in 2003

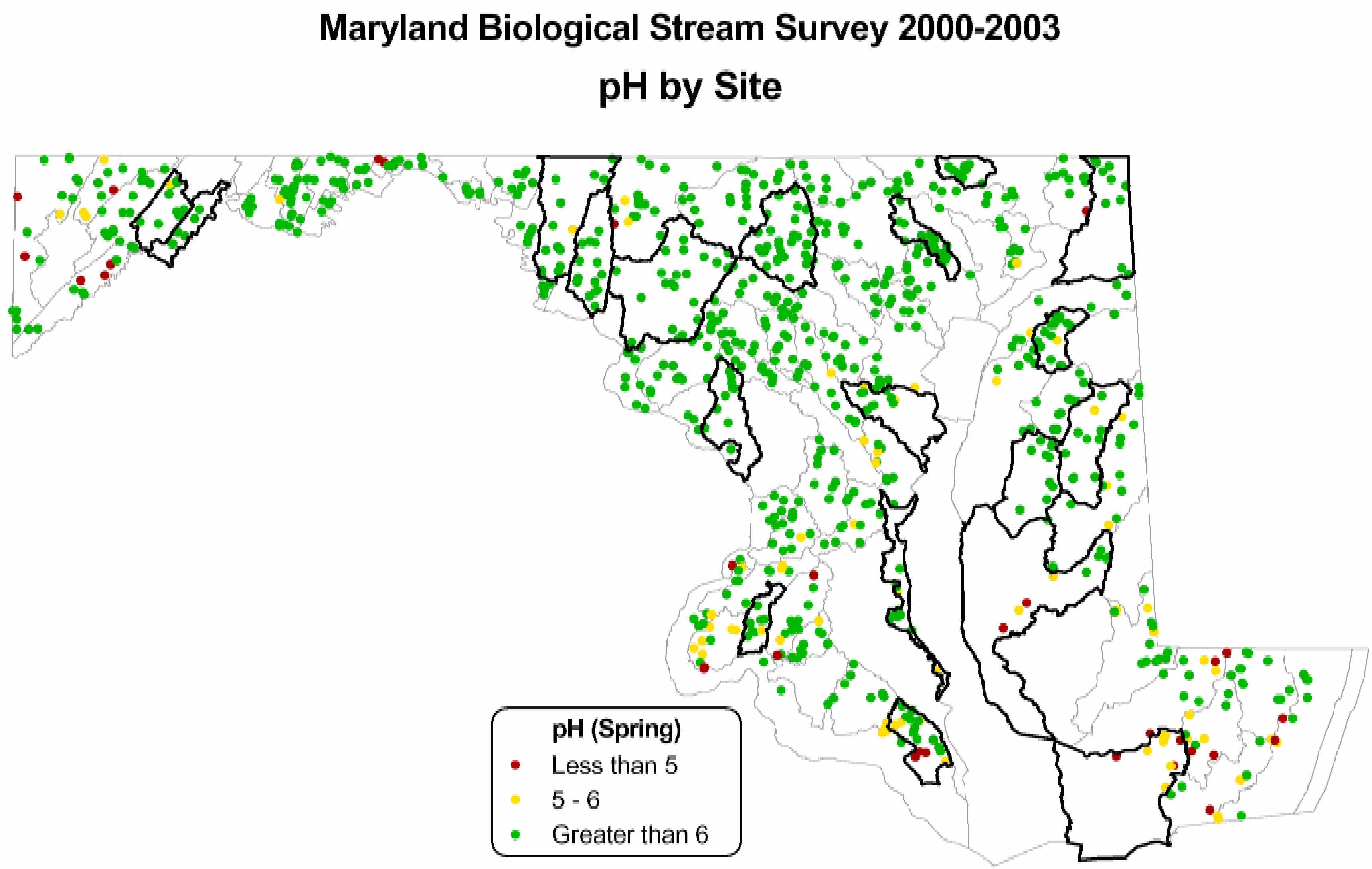

Figure 3-11. Distribution of spring pH values for sites sampled in the 2000, 2001, 2002, and 2003 MBSS. PSUs sampled in 2003 have bold outlines.

Results were used to estimate the extent of low spring pH conditions within each PSU as the percentage of stream miles with pH < 6 (Figure 3-12; Appendix Table B-7). For spring 2003, the greatest extent of low pH was estimated in Honga River PSU, where the 90% confidence interval indicated that 11 to 69% of stream miles had pH < 6. Several other PSUs had slightly lower percentages of stream miles with pH < 6. Note that even in the 10 PSUs where no pH values < 6 were observed, the upper limit of the 90% confidence interval ranged from 16 to 31%, indicating the potential for low pH conditions to exist.

3.2.2 Low Acid Neutralizing Capacity

Although pH is the most commonly used measure of acidification, ANC is a better overall measure of acidification and acid sensitivity, because it also indicates which systems are likely to become acidified under episodic conditions. The following critical ANC values are used to characterize streams according to acid sensitivity: < 0 µeq/L (acidic), 0 < ANC < 50 µeq/L (highly sensitive to acidification), 50 < ANC < 200 µeq/L (sensitive to acidification), and > 200 µeq/L (not sensitive to acidification.

ANC values measured during spring 2003 are shown in Figures 3-13 and 3-14, as well as Appendix Table B-8. Nine PSUs, primarily those in Western Maryland and the Southern Coastal Plain, had sites with ANC < 50 µeq/L. As shown in Figure 3-15 (Appendix Table B-9), PSUs with the greatest estimate stream length with ANC < 50 µeq/L were Honga River PSU, Port Tobacco River, and St. Mary's River. Estimates of the percentage of stream miles with ANC < 200 µeq/L follow the geographic pattern noted in the MSSCS and Round One MBSS, with the greatest extent of acid-sensitive streams in Western Maryland and the Southern Coastal Plain (Figure 3-16, Appendix Table B-10).

3.2.3 Likely Sources of Acidity

In estimating the extent of acidification of Maryland streams, it is important to understand how acidic deposition, acid mine drainage (AMD), agricultural runoff, and natural organic materials contribute to the observed acidification. Acidic deposition is the contribution of material from atmospheric sources, both as precipitation (wet) and particulate (dry) deposition. Acidic deposition is generally associated with elevated concentrations of sulfate and nitrate in precipitation. AMD results from the oxidation of iron and sulfur from mine spills and abandoned mine shafts and is known to cause extreme acidification of surface waters. Streams strongly impacted by AMD exhibit high levels of sulfate, manganese, iron, and conductivity. A third source of acidification is surface runoff from agricultural lands that are fertilized with high levels of nitrogen or other acidifying compounds. Lastly, the natural decay of organic materials may contribute to acidity in the form of organic anions, as in blackwater streams associated with bald cypress wetlands. Streams dominated by organic sources of acidity are often characterized by high concentrations of dissolved organic carbon and organic anions. Available water chemistry and land use data were used to screen for likely acidifying sources following the method employed in Round One analysis (Roth et al. 1999).

Results of the 2003 acid source screening indicate patterns that closely follow the results found in Round One of the Survey. A total of 71 sites (approximately 34%) sampled in 2003 had ANC < 200 µeq/L, an indication of acidification or acid sensitivity. A combination of organic ions and acidic deposition contributed to the acidification of two sites in the Honga River PSU, eight sites in the Pocomoke Sound PSU, and one site in the Severn/Magothy Rivers. Organic ions alone contributed to the acidification of one site in the Pocomoke Sound PSU. Agriculture contributed to the acidification of two sites in Broad Creek, one site in the Lower Monocacy River, five sites in the Honga River PSU, and three sites in Tuckahoe Creek. In 2003, no sites showed acidification impacts contributed to by AMD alone. Three sites in Georges Creek and three sites in Potomac River Lower North Branch showed impacts due to a combination of AMD and acidic deposition.

Acidic deposition effects were more widespread, affecting PSUs throughout the State, concentrating in the Southern Coastal Plain and Western Maryland. Forty-two sites were affected in 14 PSUs: St. Mary's River (9 sites), Port Tobacco River (6 sites), Georges Creek (5 sites), Magothy/Severn Rivers (5 sites), Potomac River Lower North Branch (4 sites), West Chesapeake Bay (3 sites), Honga River PSU (2 sites), Lower Elk River PSU (2 sites), and one site in each of the following PSUs – Antietam Creek, Broad Creek, Catoctin Creek, Liberty Reservoir, Lower Monocacy River, and Pocomoke Sound PSU.

3.3 PHYSICAL HABITAT

Although many water resource programs tend to focus on water chemistry-based definitions of stream quality, physical habitat degradation can have an equal or greater effect on stream ecosystems and their biological communities. Habitat loss and degradation has been identified as

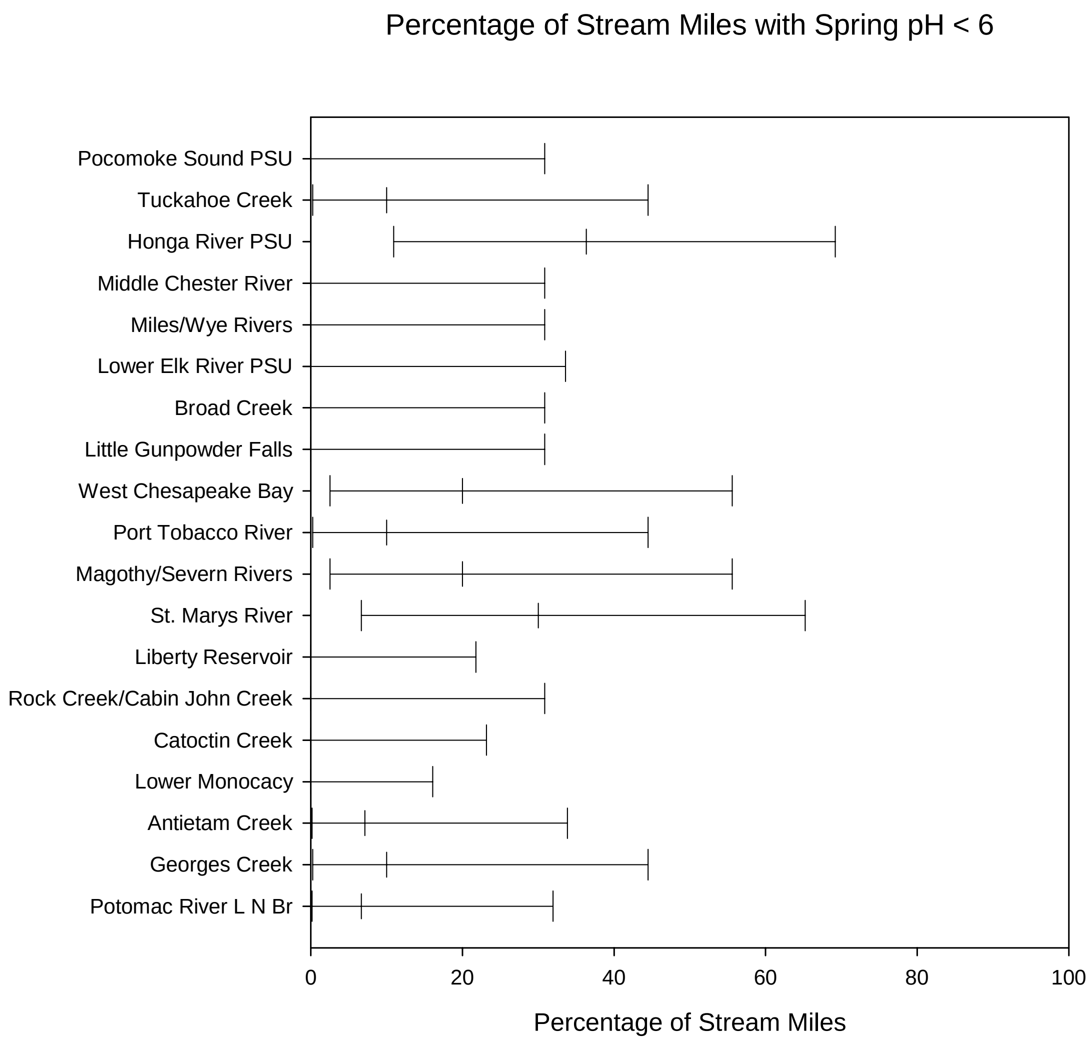

Figure 3-12. Percentage of stream miles with spring pH < 6.0 for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

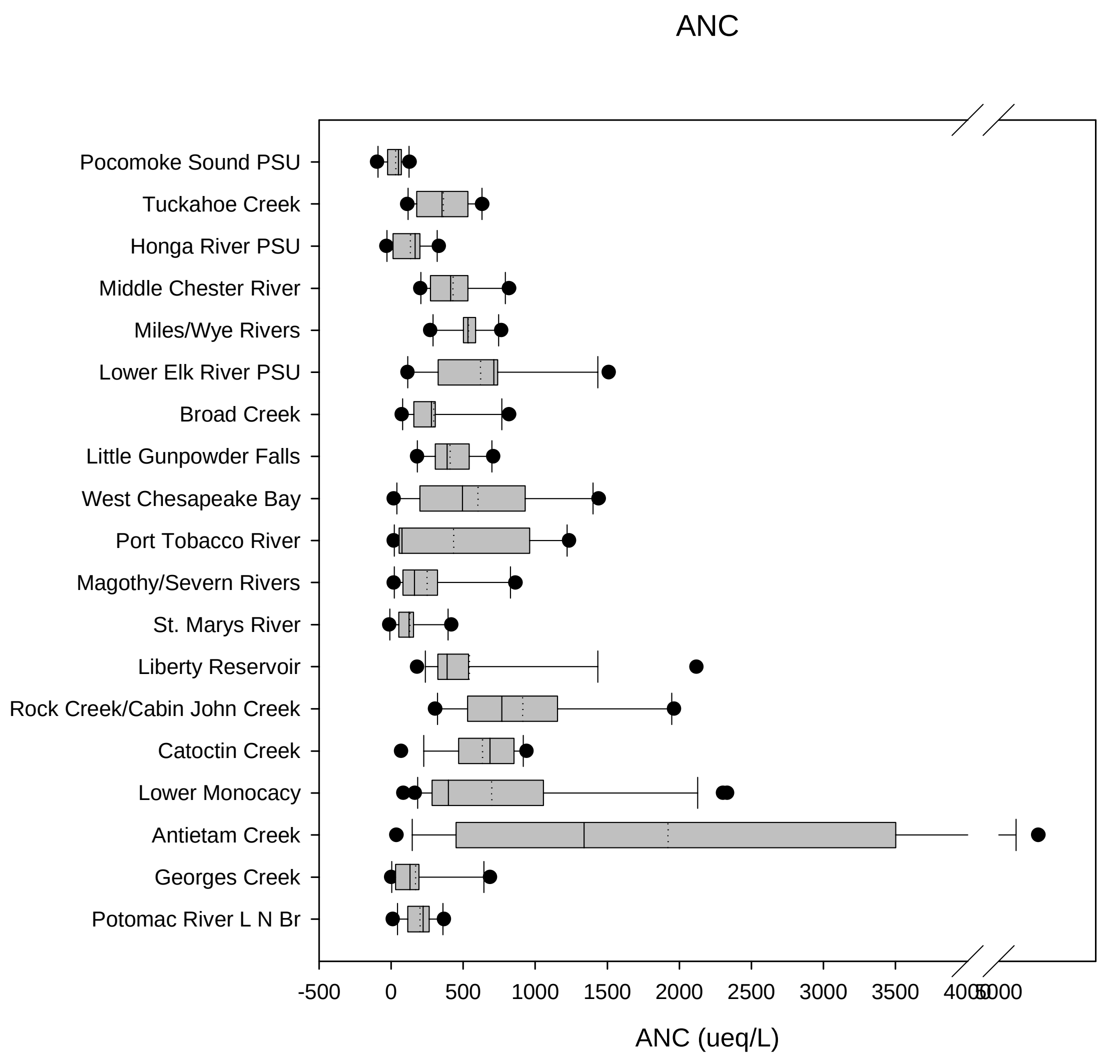

Figure 3-13. Distribution of Acid Neutralizing Capacity (ANC) values in µeq/L for the MBSS PSUs sampled in 2003

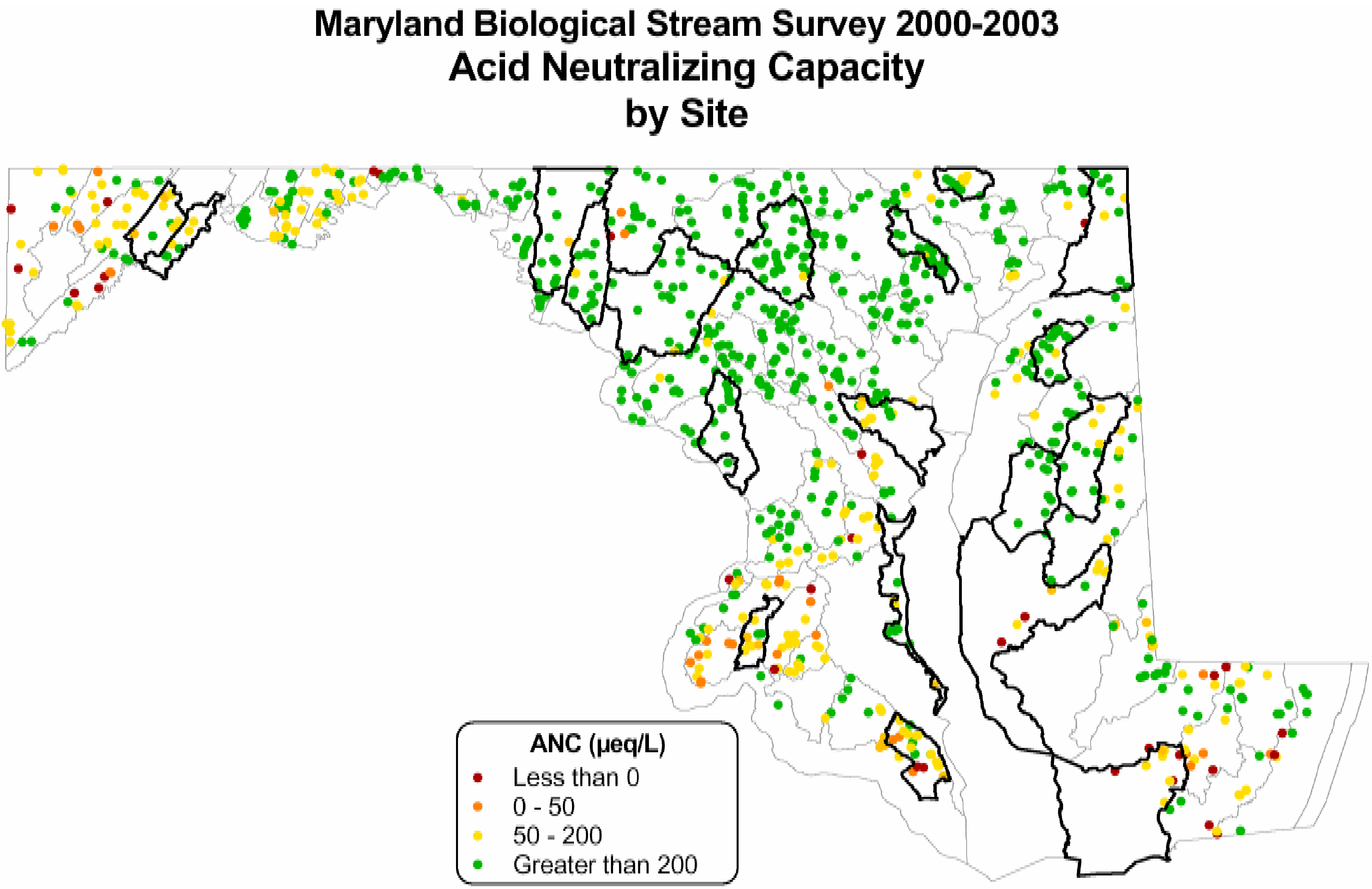

Figure 3-14. Distribution of Acid Neutralizing Capacity (ANC) values for the sites sampled in the 2000, 2001, 2002, and 2003 MBSS. PSUs sampled in 2003 have bold outlines.

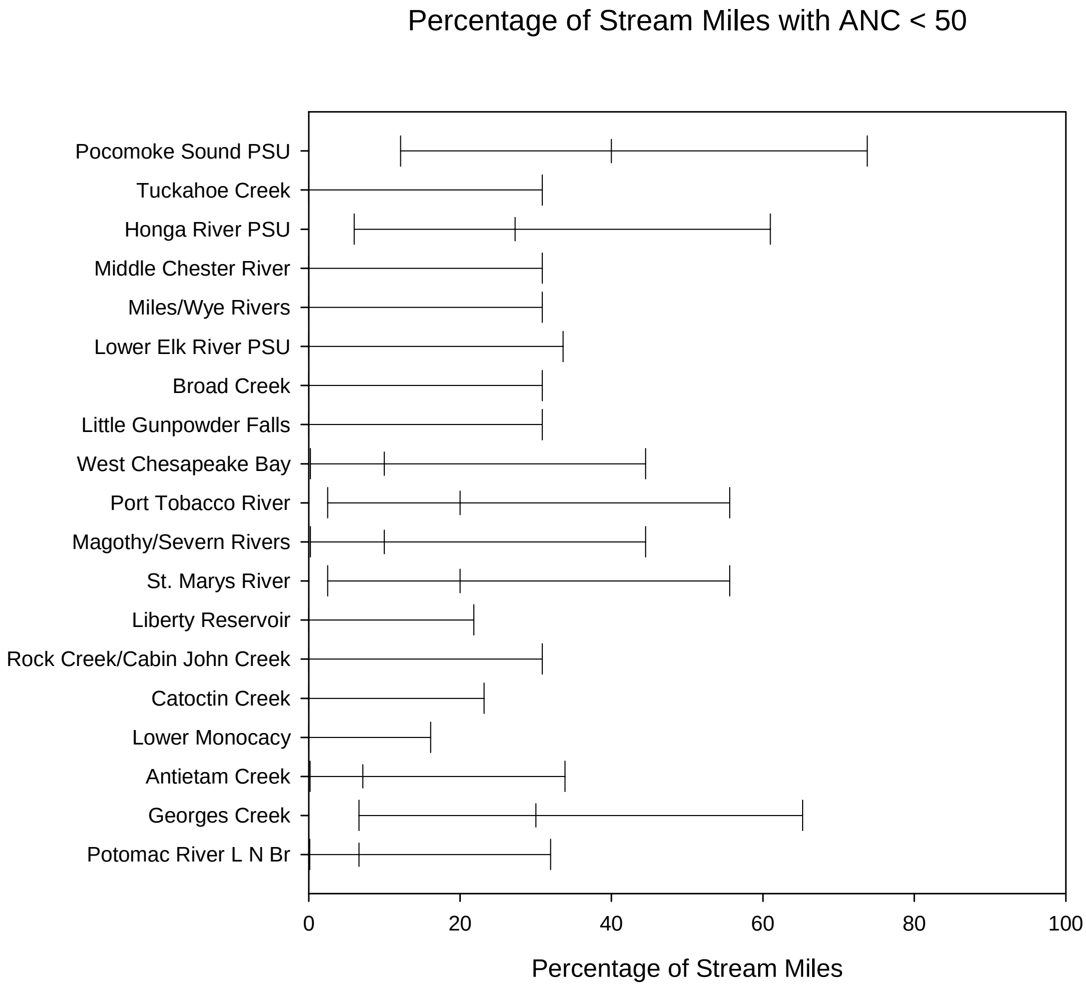

Figure 3-15. Percentage of stream miles with Acid Neutralizing Capacity (ANC) < 50 µeq/L for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

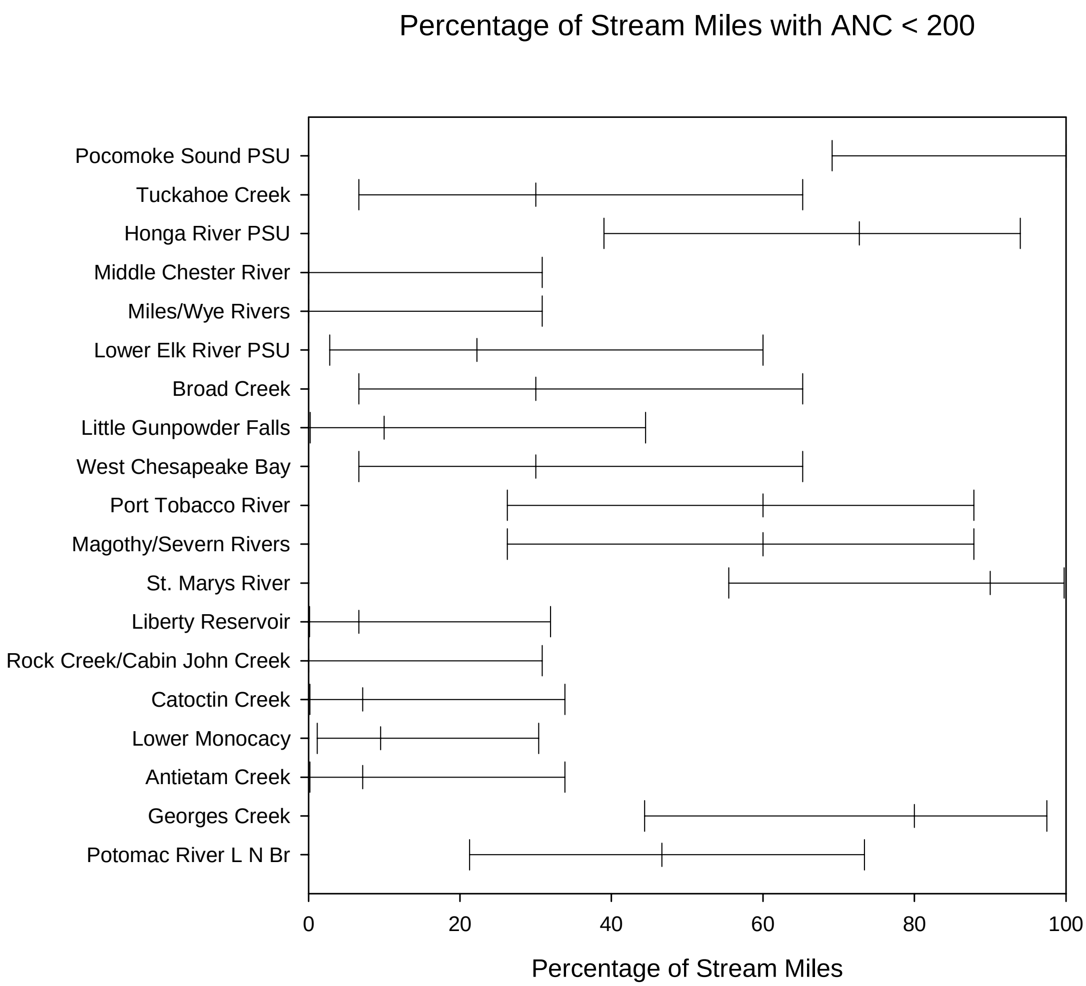

Figure 3-16. Percentage of stream miles with Acid Neutralizing Capacity (ANC) < 200 µeq/L for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

one of the six critical factors affecting biological diversity in streams worldwide (Allan and Flecker 1993). Habitat degradation can result from a variety of human activities occurring within the stream itself or in the surrounding riparian zone and watershed. Typical instream impacts include sedimentation, impoundment, and stream channelization. Urban development, timber harvesting, agriculture, livestock grazing, and the draining or filling of wetlands are well-known examples of human activities affecting streams at a broader scale. In watersheds affected by anthropogenic stress, riparian (streamside) forests can ameliorate inputs of nutrients, sediments, and other pollutants to streams. They also provide other functions, such as shade, and inputs of leaf litter and large woody debris.

The Survey collects data to assess the extent and type of physical habitat degradation occurring in Maryland streams. A provisional Physical Habitat Indicator (PHI), developed during Round One of the MBSS (Hall et al. 1999), has been used in earlier reports to assess the overall status of physical habitat conditions. In this report, we apply a revised PHI derived from the large dataset. In addition, examination of individual parameters are useful for assessing geomorphic processes, integrity of riparian vegetation, and alterations to the natural temperature regime. Data from 2003 MBSS sampling were analyzed to examine key physical habitat parameters that may affect biological communities.

3.3.1 Physical Habitat Index

A revised PHI was developed using MBSS data through 2000 (Paul et al. 2003). This new PHI was used to score sites sampled in 2003. Because of underlying differences in stream types, separate PHIs are applied on each of three geographic strata: the Highland, Piedmont, and Coastal Plain. Four physical habitat variables are common to all three indices: (1) bank stability, (2) epibenthic substrate, (3) shading, and (4) remoteness. Five additional variables are included in one of two indices: (1) riparian width, (2) riffle quality, (3) instream wood, (4) instream habitat quality, and (5) embeddedness.

Index scores are adjusted to a centile scale that rates each sample segment as follows:

- Scores of 81 to 100 are rated minimally degraded
- Scores of 66 to 80 are rated partially degraded
- Scores of 51 to 65 are degraded
- Scores of 0 to 50 are rated severely degraded

Scores for MBSS 2003 sampling were computed by comparison with the same distributions of metric values that were used to develop the PHI. Thus, indicator scores may be interpreted using the narrative ratings described above.

Revised PHI results by PSU are shown in Figure 3-17 and Appendix Table B-11. Scores varied widely within and among PSUs. No PSUs had mean scores indicating severe degradation. Only Potomac River Lower North Branch had a mean score indicating minimal degradation (83.01). The remaining scores spanned the range of partially degraded to degraded. The geographic distribution of mean PHI socres is shown on a statewide map (Figure 3-18).

Stream mile estimates of the occurrence of poor to very poor PHI scores suggest that physical habitat degradation is widespread (Figure 3-19, Appendix Table B-12). The greatest extent of low PHI scores was in the Lower Elk River SPU where the 90% confidence interval predicted that from 26 to 88% of stream miles were degraded or severely poor degraded.

3.3.2 Geomorphic Processes

Channelization can substantially alter the character of the stream. Historically, streams were commonly channelized to drain fields and to provide flood control. Today, streams in urban areas are often channelized to accommodate road-building or to drain stormwater from developed areas. When previously meandering streams are straightened, they may lose their natural connection to the floodplain, with significant adverse consequences for the stream ecosystem. For example, increased flows during storm events can lead to greater scouring, greater bank instability, and disruption of the natural pattern of riffle and pool habitats. At other times, decreased baseflows can result in stagnant ditches with substrates degraded by heavy sediment deposition.

MBSS 2003 results indicate that stream channelization is common in some Maryland watersheds, particularly in the Coastal Plain (Figure 3-20, Appendix Table B-13). The most widespread incidence of channelization was observed in the Pocomoke River PSU (90% confidence interval; 69-100% of stream miles channelized).

Bank erosion is a common symptom of stream problems. Erosion within the stream channel, often associated with "flashy" flow regimes in highly urbanized watersheds, can scour banks and mobilize sediment. In fact, much of the sediment transported and deposited within the stream

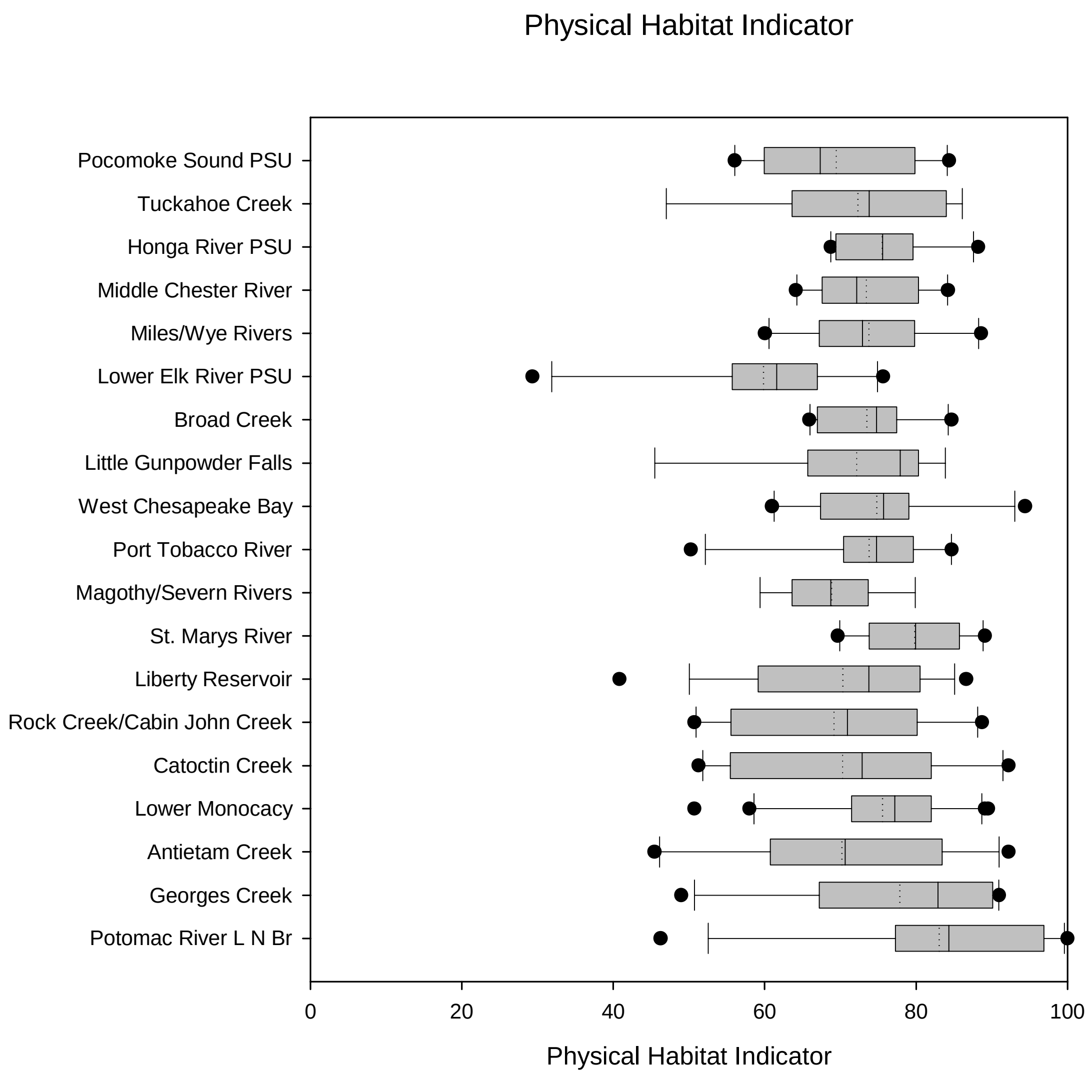

Figure 3-17. Distribution of Physical Habitat Indicator (PHI) scores for the MBSS PSUs sampled in 2003

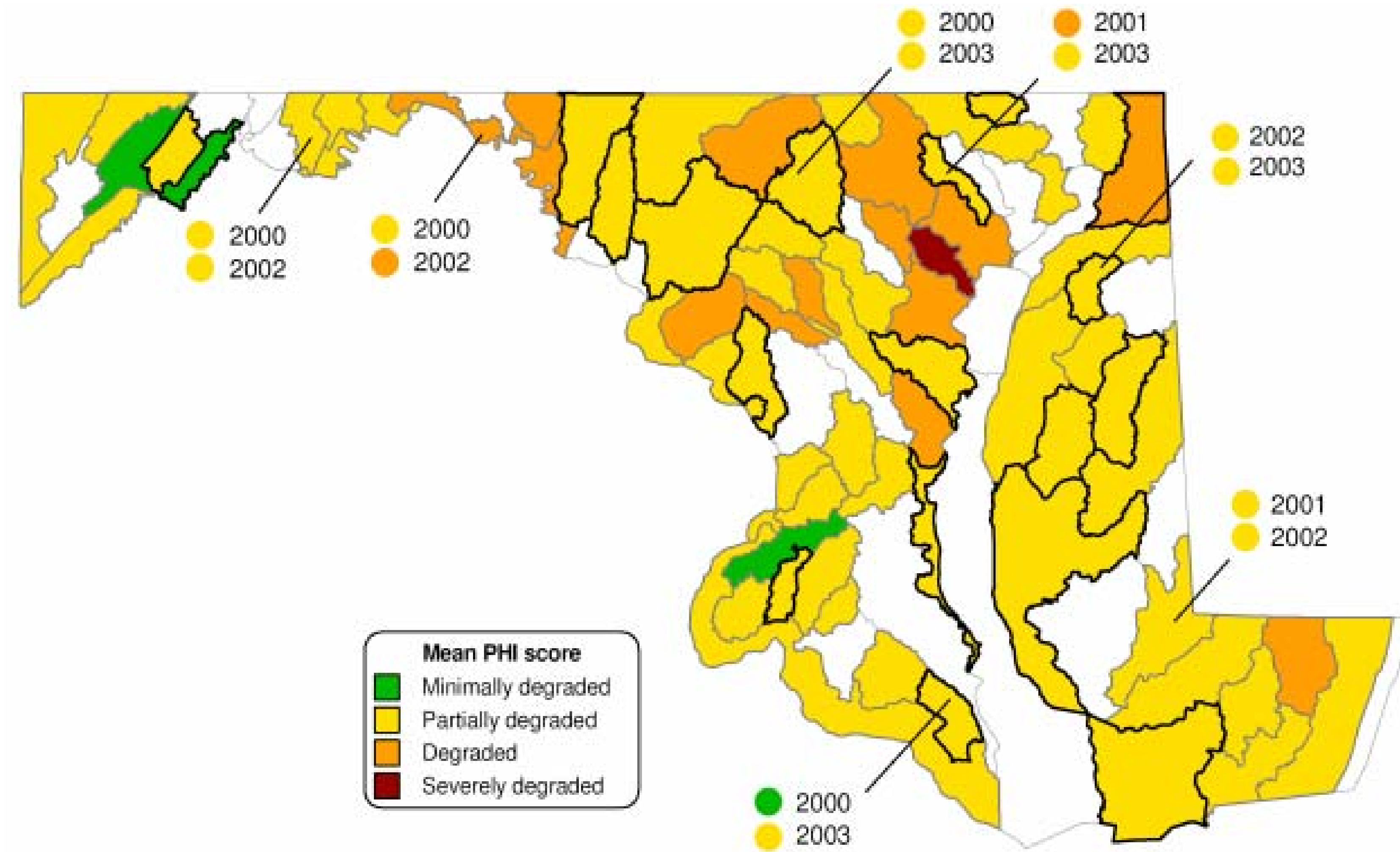

Figure 3-18. Mean Physical Habitat Indicator (PHI) scores for the MBSS PSUs sampled in 2000 2001, 2002, and 2003. PSU's sampled in 2003 have bolder outlines than those sampled in 2000-2002. Five PSUs that were sampled in previous years were also sampled in 2003.

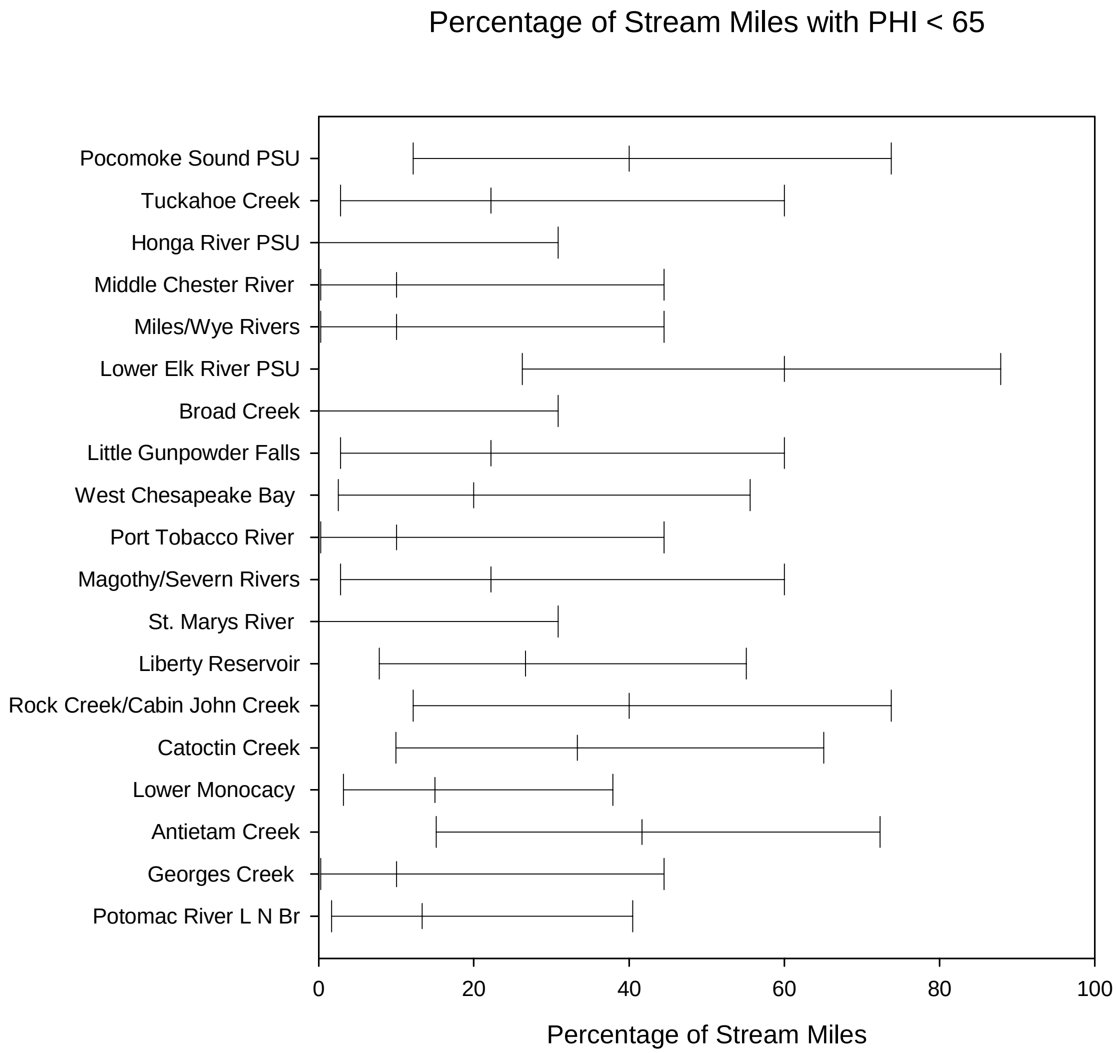

Figure 3-19. Percentage of stream miles with Physical Habitat Indicator (PHI) < 42 (poor to very poor) for the MBSS PSUs sampled in 2003

often originates from in-channel erosion rather than overland flow. Bank erosion is a sign of channel instability (side-cutting and/or down-cutting). While the lack of streambank vegetation can contribute to bank erosion, severe erosion can in turn destabilize vegetation, causing even large tress to fall. In addition, sediments eroded from banks can become resuspended after initial settling, increasing turbidity and deposition in downstream areas.

Moderate to severe bank erosion occurs commonly in Maryland streams, as seen in MBSS 2003 sampling results (Figure 3-21, Appendix Table B-14). Many watersheds had a high occurrence of bank erosion. The greatest extent of moderate to severe bank erosion was estimated for Rock Creek/Cabin John Creeks (90% confidence interval; 56 to 100% of stream miles).

Within each 75-meter segment sampled, field estimates of the amount of eroded bank area were made. Mean values by PSU were used to estimate the extent of eroded area (square meters) per stream mile. The highest values were in Port Tobacco River, Rock Creek/Cabin John Creeks, Little Gunpowder Falls, and West Chesapeake Bay. Per-mile areas were then used to project the total surface area of bare, eroded bank in each PSU (Table 3-2). Combined the eroded bank area in these 19 PSUs totals sampled in 2003 more than 510 acres.

Significant deposition of gravel and fine sediments can lead to bar formation. Although some formation of bars is natural, more severe bar formation can signal channel instability related to bank erosion and altered flow regimes

Exacerbated bar formation was observed in all watersheds sampled in 2003 (Figure 3-22, Appendix Table B-15). Estimates of the percentage of stream miles experiencing moderate to severe bar formation were highest in Port Tobacco River (90% confidence interval; 44 to 97% of stream miles) followed closely by Rock Creek/Cabin John Creeks (35 to 93% of stream miles).

3.3.3 Vegetated Riparian Buffers and Woody Debris

A complete characterization of stream habitat goes beyond in-channel measures and includes the riparian zone adjacent to the stream. The effectiveness of the riparian buffer in mitigating nutrient loading and providing other benefits to the stream varies with the type and amount of riparian vegetation. MBSS records data on both the type and extent of local riparian vegetation, estimated as the functional width of the riparian buffer along each side of the 75-meter segment.

Lack of riparian vegetation on at least one stream bank was observed within 11 of the 19 PSUs sampled. Data were used to estimate the percentage of stream miles lacking riparian buffer vegetation on at least one bank (Figure 3-23) or on both banks (Figure 3-24, Appendix Tables B-16 and B-17).

Table 3-2. Eroded streambank area (in m^2) by stream miles and total eroded streambank area per PSU sampled in MBSS 2003

Watershed	Mean Eroded Area per $75m^2$	Mean Eroded Area per Mile	Number of Stream Miles in PSU	Acreage of Eroded Area
Antietam Creek	22	471.9	225.9	26.7
Broad Creek	40	858	44.1	9.5
Catoctin Creek	30	643.5	166.8	26.8
Georges Creek	14	300.3	83.35	6.3
Honga River PSU	5	107.25	75.14	2.0
Liberty Reservoir	54	1158.3	184	53.3
Little Gunpowder Falls	85	1823.25	73.22	33.4
Lower Elk River PSU	46	986.7	131.3	32.4
Lower Monocacy	49	1051.05	454.6	119.5
Magothy/Severn Rivers	32	686.4	76.2	13.1
Middle Chester River	14	300.3	45	3.4
Miles/Wye Rivers	40	858	70.2	15.1
Pocomoke Sound PSU	23	493.35	51.5	6.4
Port Tobacco River	113	2423.85	46.7	28.3
Potomac River L N Br	14	300.3	148.3	11.1
Rock Creek/Cabin John Creek	104	2230.8	84.8	47.3
St. Marys River	53	1136.85	69.7	19.8
Tuckahoe Creek	36	772.2	175.9	34.0
West Chesapeake Bay	59	1265.55	70.6	22.3

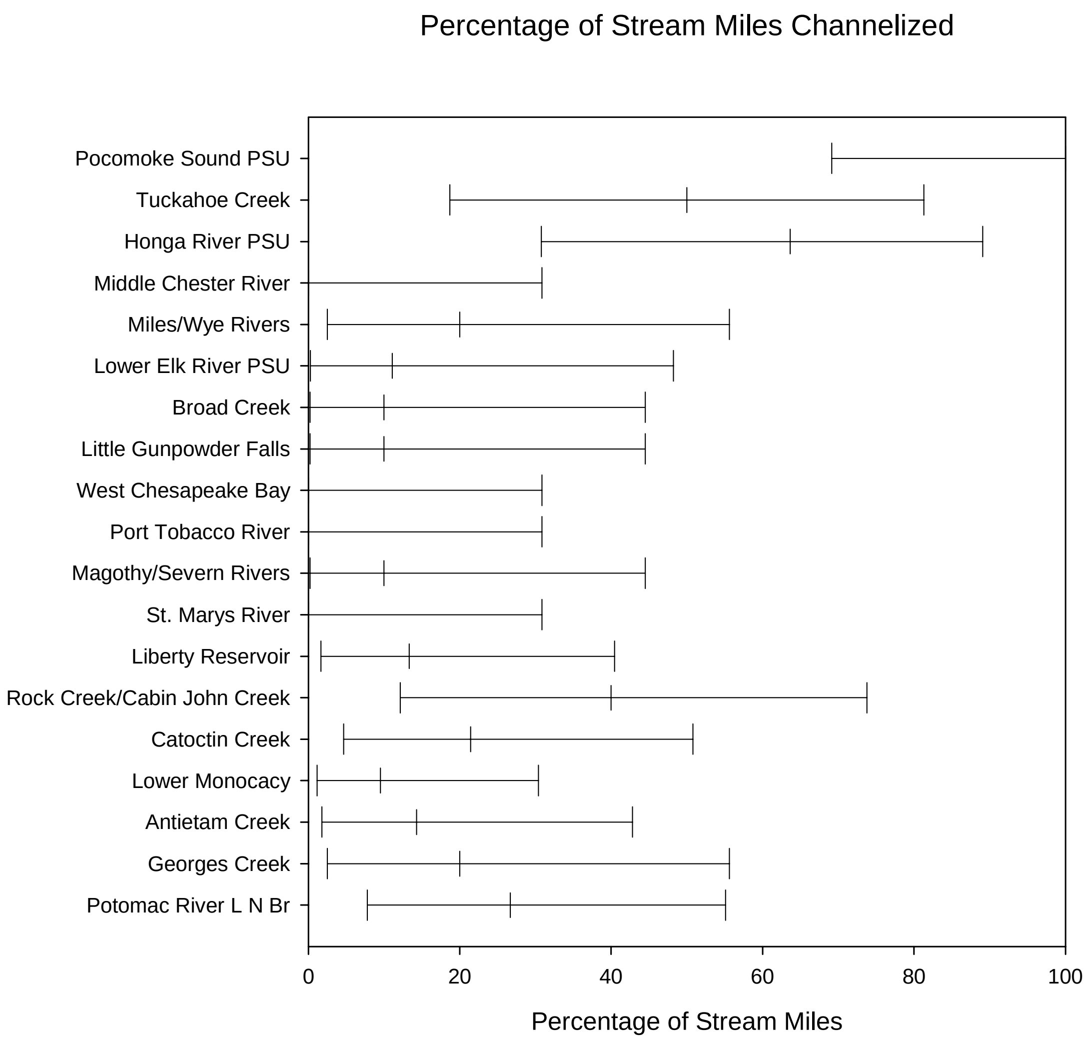

Figure 3-20. Percentage of stream miles channelized for the MBSS PSUs sampled in 2003

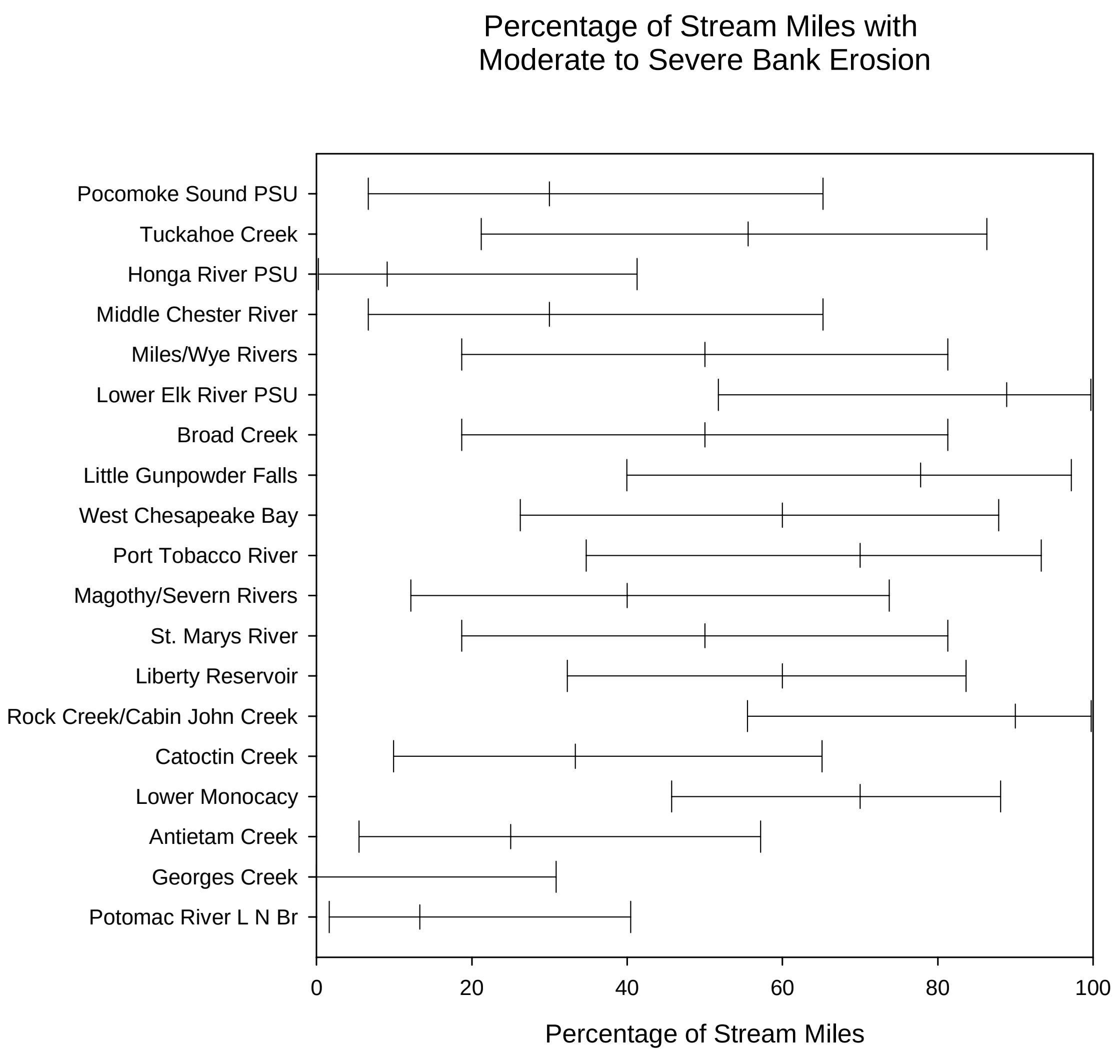

Figure 3-21. Percentage of stream miles with moderate to severe bank erosion for the MBSS PSUs sampled in 2003

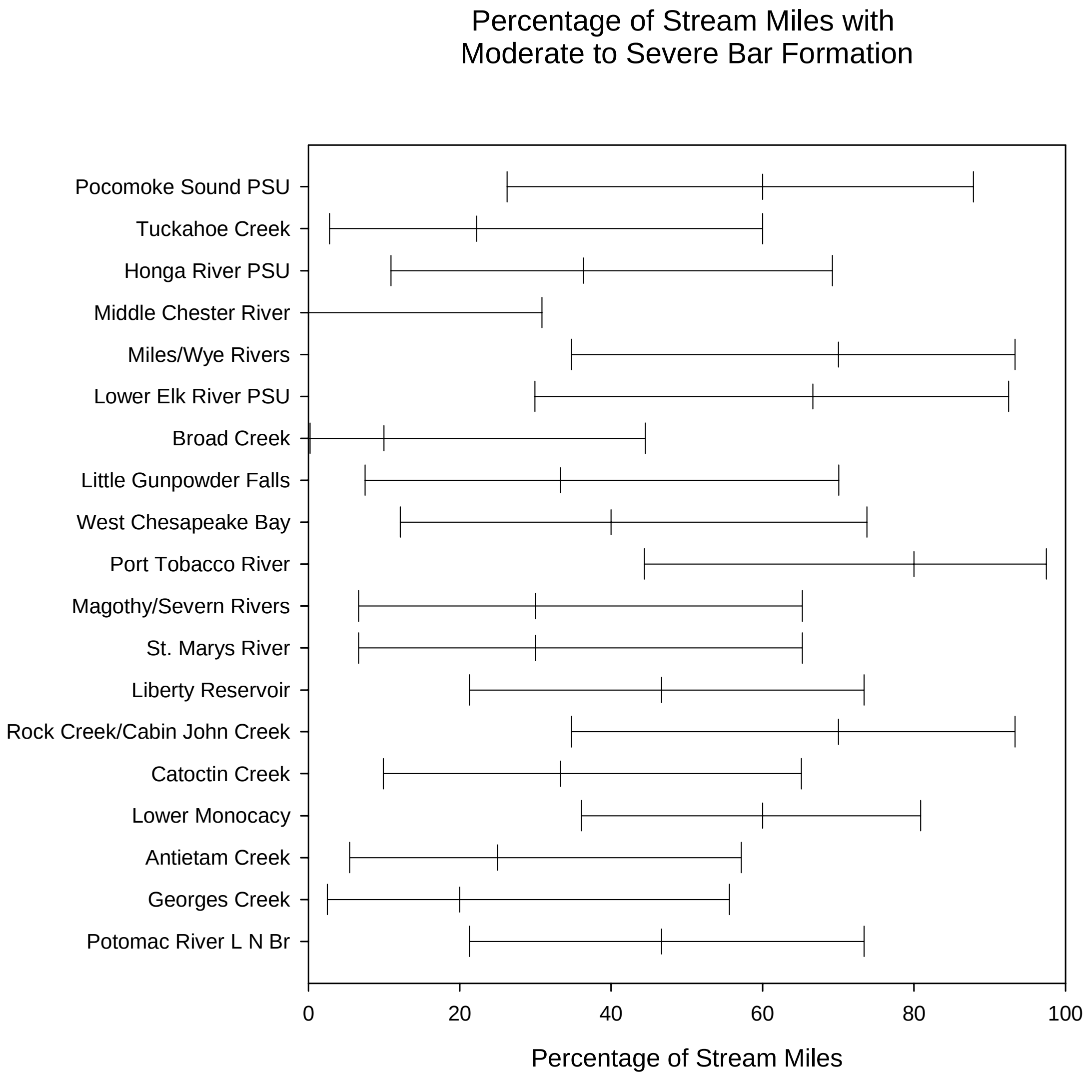

Figure 3-22. Percentage of stream miles with moderate to severe bar formation for the MBSS PSUs sampled in 2003

The presence of non-native plant species is another indication of the integrity of the riparian plant community. Invasive species such as multiflora rose, mile-a-minute, and Japanese honeysuckle can crowd out native plants. Several watersheds appeared affected by the extensive presence of non-native plants (Figure 3-25, Appendix Table B-18). In cases of high abundance along streams, these species can prevent natural regeneration and/or growth of intentionally planted trees and are thus a threat to buffer reestablishment.

Rootwads and other types of woody debris provide habitat, high flow refugia, cover, and shade for a variety of stream biota. They also absorb energy during storm events, thereby reducing erosion and slowing restraint transport. When riparian forests are removed, this important source of woody debris is lost. To assess the availability of this key habitat feature, the numbers of rootwads and other woody debris within each 75-meter segment were recorded by MBSS field crews. The total number of instream pieces of woody debris and rootwads was relatively consistent throughout the 19 PSUs sampled (Figure 3-26, Appendix Table B-19), although sites with substantially higher amounts were located in both the Port Tobacco and St. Mary's River PSUs. Along with wood found within the wetted width of the stream itself, other near-channel (but dewatered) woody debris is a potential future source of habitat. Separate results for instream, dewatered, and total counts of woody debris and rootwads are shown in Figures 3-27 to 3-32 (Appendix Tables B-20 to B-25). The amount of rootwads and large woody debris in Maryland streams is expected to grow over time as forestry professionals further recognize the critical role that wood plays in stream health.

3.3.4 Temperature

During 2003, MBSS deployed continuous reading temperature loggers at more than 200 sites. The long-term goal is to use temperature data to (1) better classify and characterize coldwater streams and (2) identify streams stressed by temperature changes, such as spikes from rapid inputs of warm water running off impervious surfaces during summer storms. Data were recorded at 20-minute intervals with loggers set to record the highest value observed during each 20 minute interval. Initial data analyses consisted of a quality assurance review (to exclude sites where temperature loggers were lost or not submerged in the stream during low flow periods), establishment of a consistent period of record, and computation o f several summary indicators. Indicators were calculated for 210 sites where the data record was complete. Generally, the period of record considered was June 1 to August 15.

Summary indicators included:

1. Mean average daily temperature
2. Mean minimum and maximum daily temperatures
3. Absolute maximum temperature
4. 95th percentile temperature
5. Percentage of readings exceeding thresholds in state water quality standards

Maryland water quality standards for temperature state that the maximum temperature may not exceed 32 °C (90 °F) in most waters, 20 °C (68 °F) in Class III Natural Trout Waters, or 23.9 °C (75 °F) in Class IV Recreational Trout Waters (COMAR 1995).

Results for sites monitored in 2003 are listed in Appendix C. Among all sites assessed, mean average daily temperatures ranged from 13.8 to 28.5 °C, indicating the presence of both coldwater and warmwater sites in the data set. The lowest mean daily minimum was 13.8 °C at a first-order site in Georges Creek. Future analyses of data from coldwater streams will assist in interpretation of IBI scores and will contribute to development of a fish IBI tailored to these systems. Trout and several non-game species require cool to cold waters. For example, EPA criteria for growth and survival of brook trout (Maryland's only native salmonid) are maximum weekly means of 19 and 24 °C. Research has found a still lower temperature of 14.4 °C as the maximum temperature for juvenile growth of brook trout (EPA 1976 and McCormick et al. 1972, as cited in Eaton et al. 1995).

Two sites that were not labeled as dry in the summer had more than 10% of their readings greater than 32 °C. A systematic review of whether any Class III or IV streams exceeded standards would require examination of site data by stream class and was beyond the scope of this report.

Examples of daily temperature data from two sites are shown in Figures 3-33 and 3-34.

3.4 NUTRIENTS AND OTHER WATER CHEMISTRY

Nutrients such as nitrogen and phosphorus are important for life in all aquatic systems. In the absence of human influence, streams contain background levels of nutrients influence that are essential to the survival of the aquatic plants and animals in that system. However, during the last several hundred years, the amount of nutrients transported to many stream systems has increased greatly as a result of anthropogenic influences such as

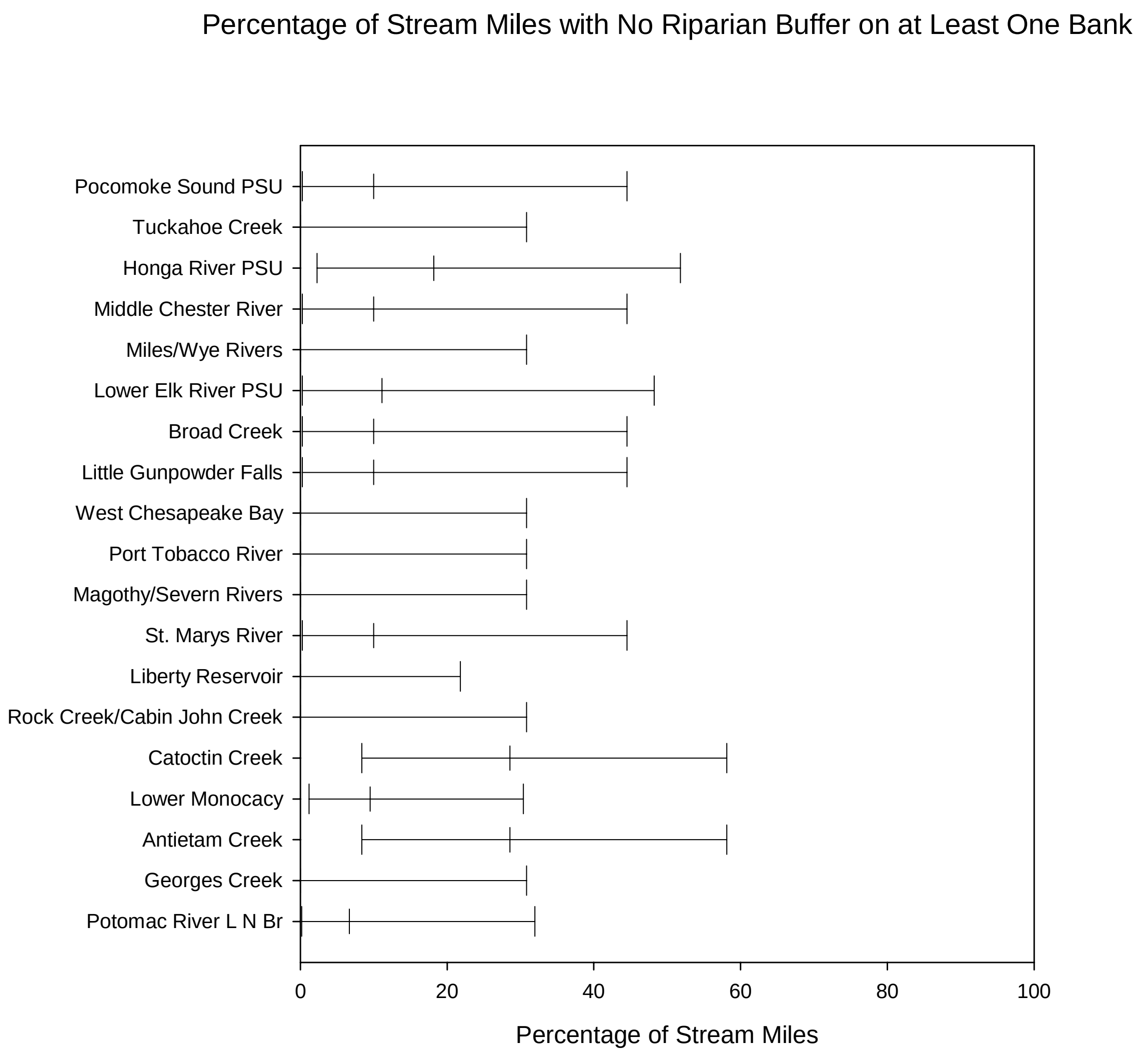

Figure 3-23. Percentage of stream miles with no riparian buffer on at least one bank for MBSS PSUs sampled in 2003 (with 90% confidence intervals)

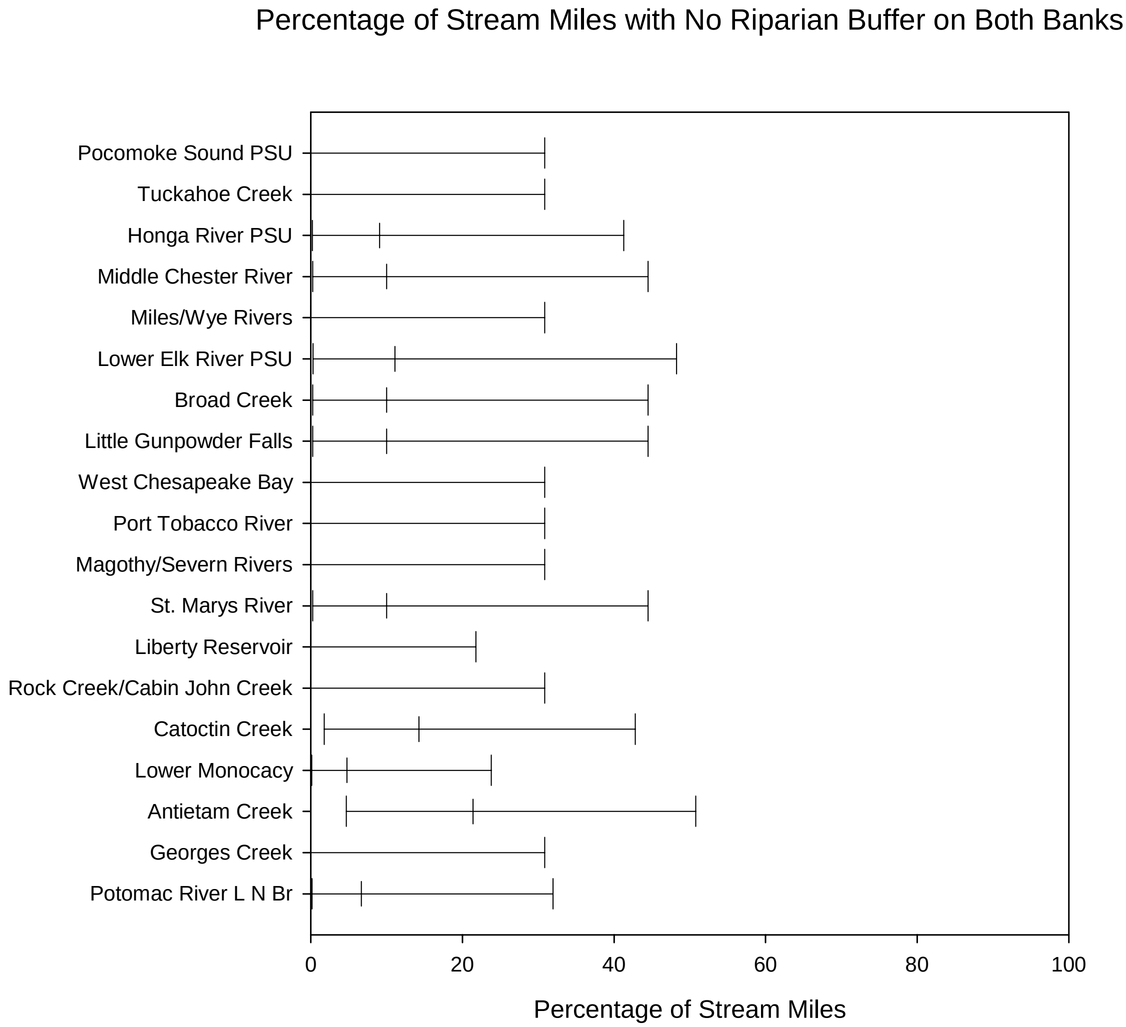

Figure 3-24. Percentage of stream miles with no riparian buffer on both banks for MBSS PSUs sampled in 2003 (with 90% confidence intervals)

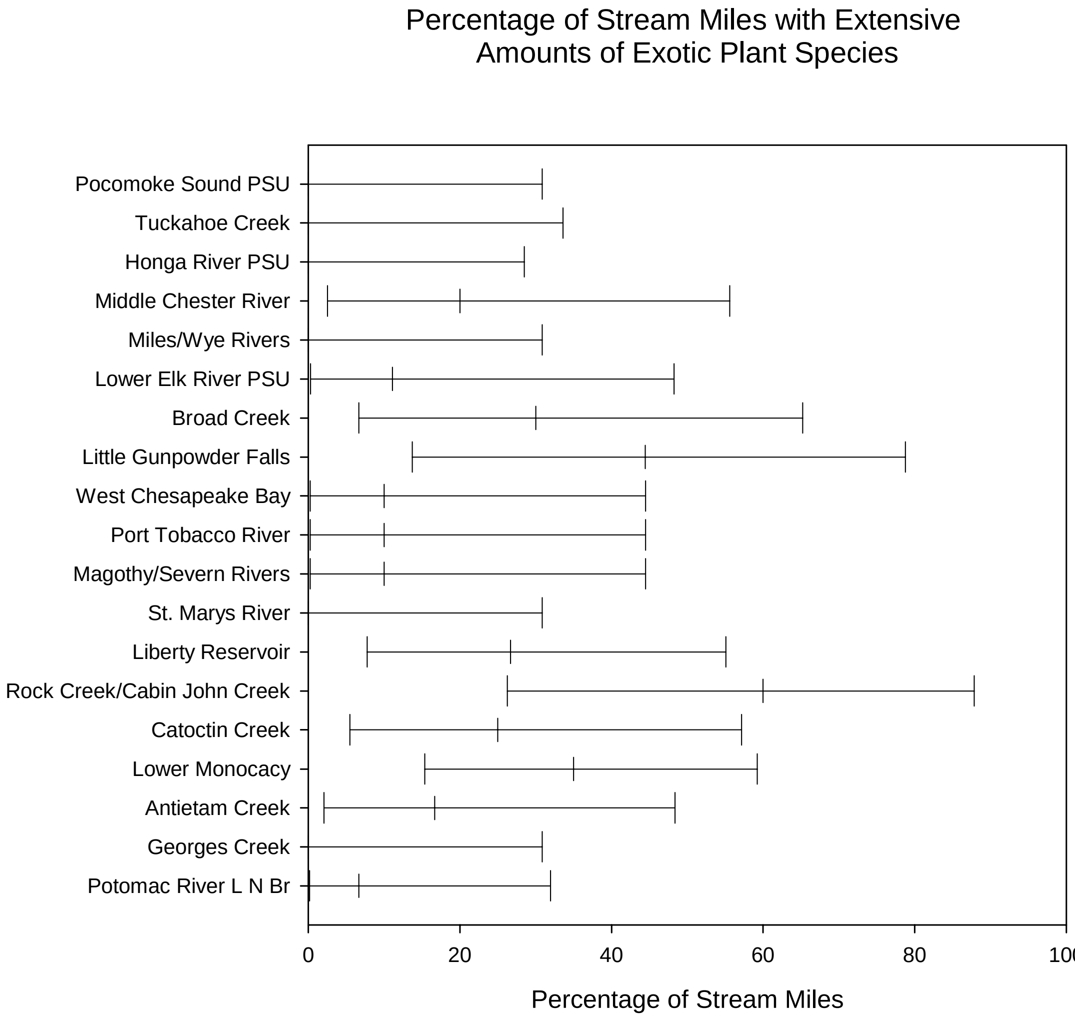

Figure 3-25. Percentage of stream miles with extensive amounts of exotic plants present for MBSS PSUs sampled in 2003 (with 90% confidence intervals)

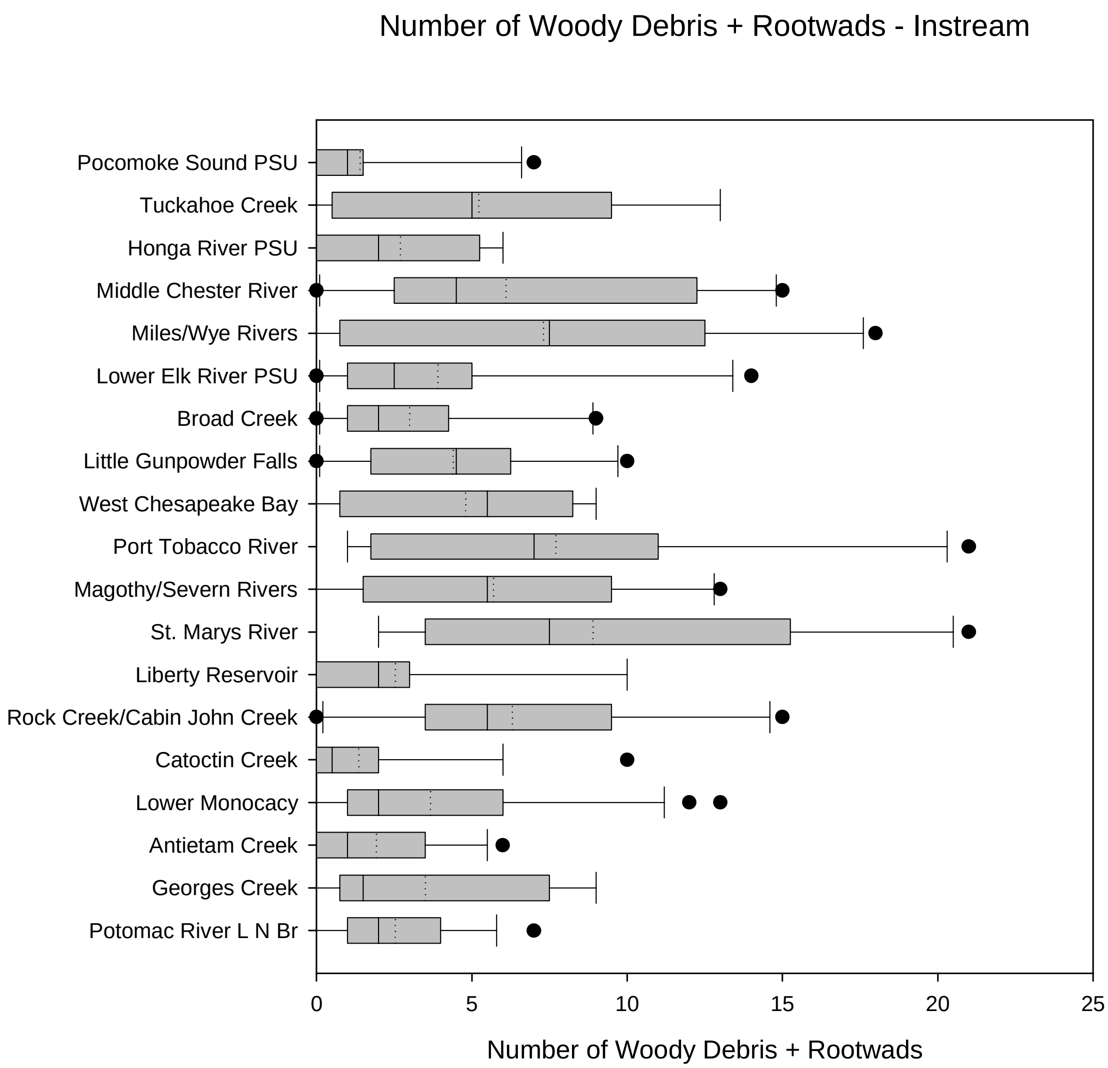

Figure 3-26 . Distribution of the sum of the total number of instream woody debris and the total number of instream rootwads per 75 m segment for the MBSS PSUs sampled in 2003

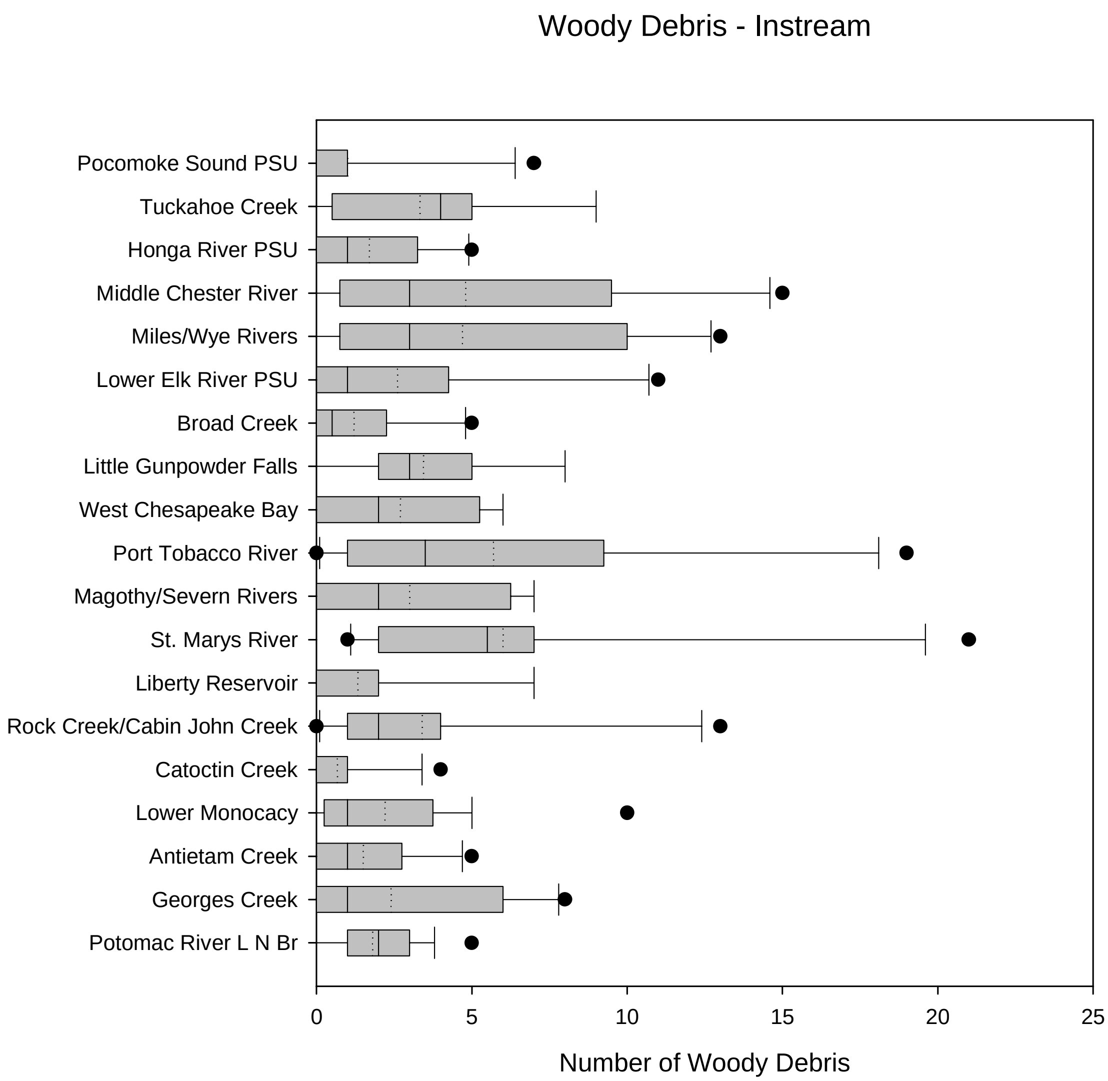

Figure 3-27. Distribution of the number of instream woody debris per 75 m segment for the MBSS PSUs sampled in 2003

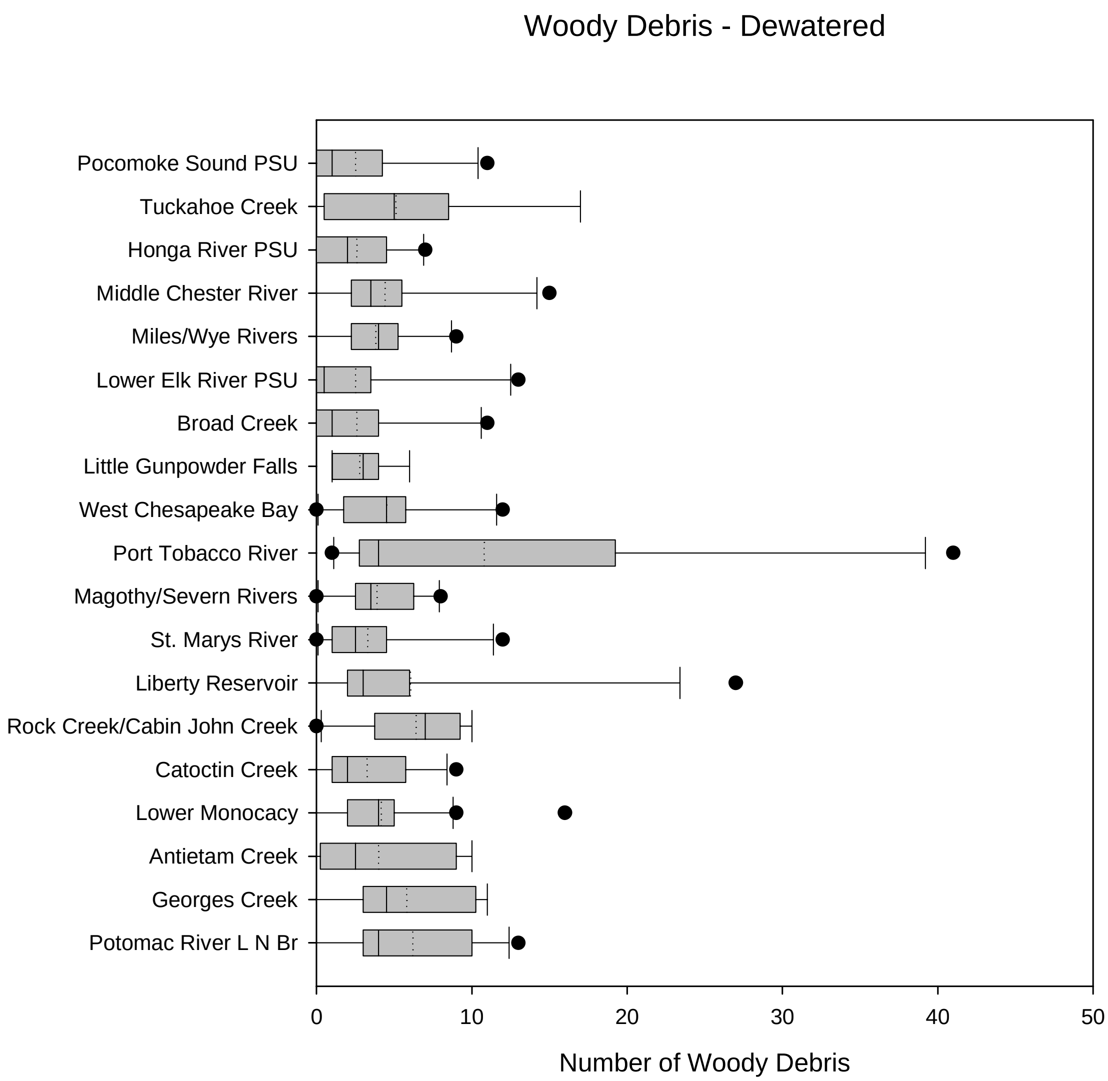

Figure 3-28. Distribution of the number of dewatered woody debris per segment for the MBSS PSUs sampled in 2003

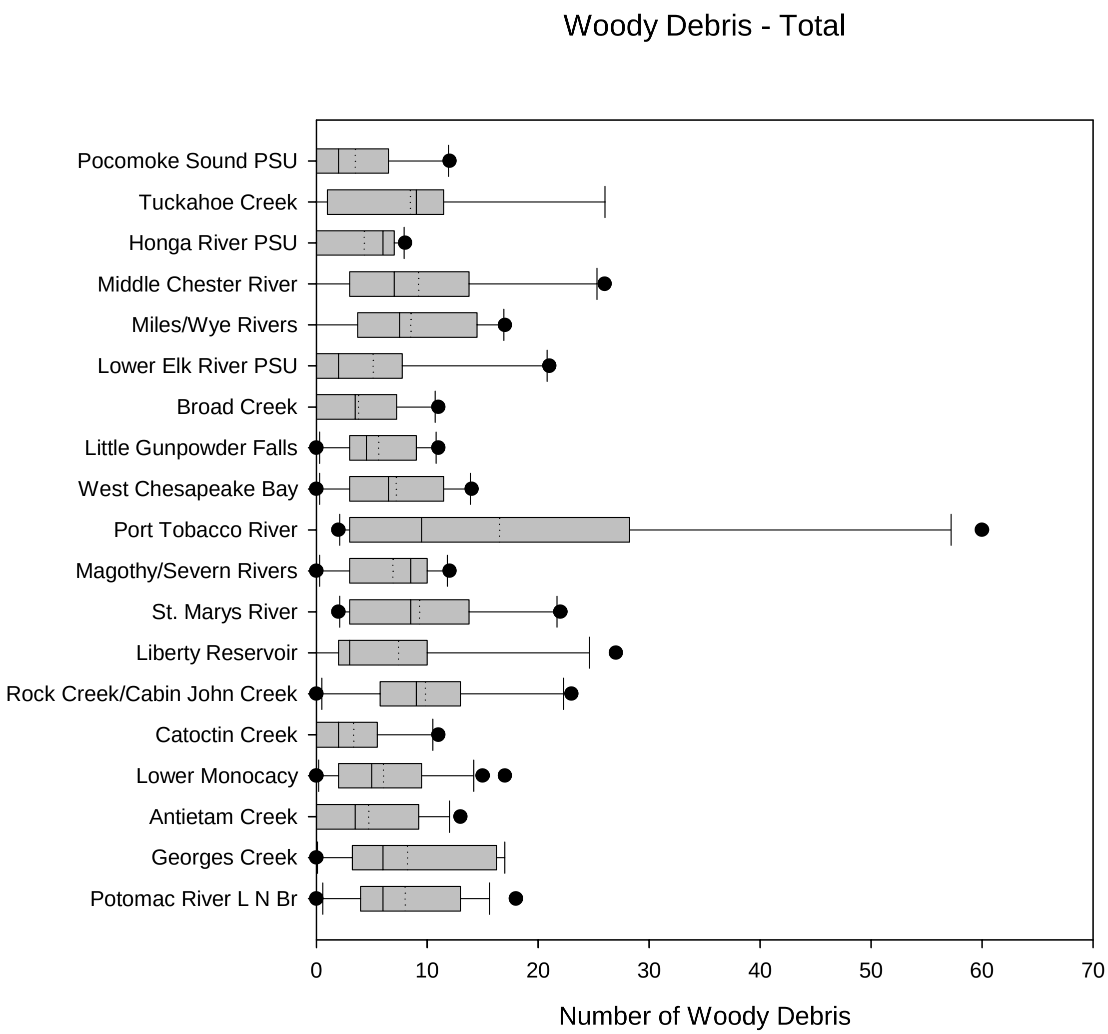

Figure 3-29. Distribution of the total number of instream and dewatered woody debris per 75 m segment for the MBSS PSUs sampled in 2003

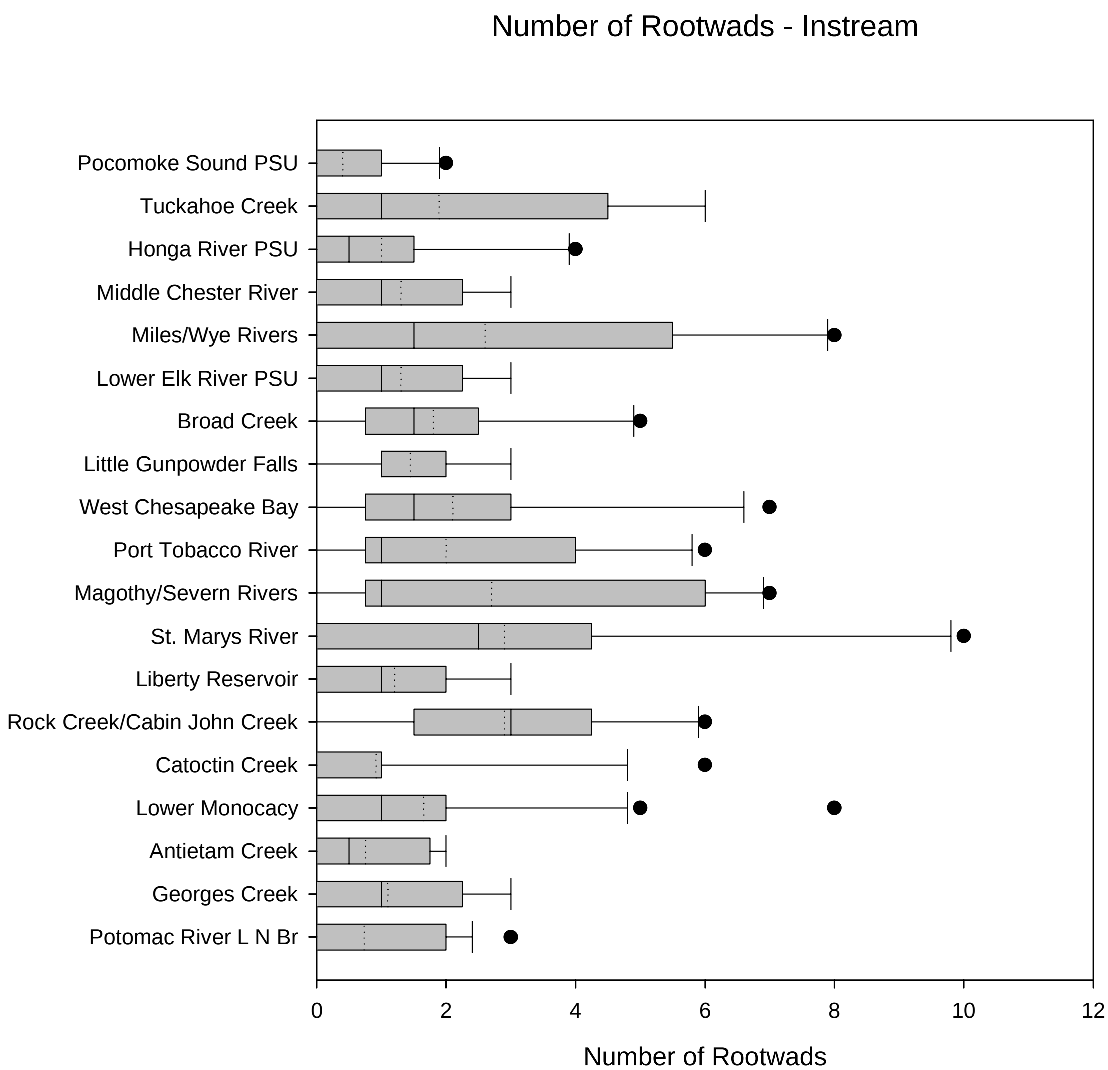

Figure 3-30. Distribution of the number of instream rootwads per 75 m segment for the MBSS PSUs sampled in 2003

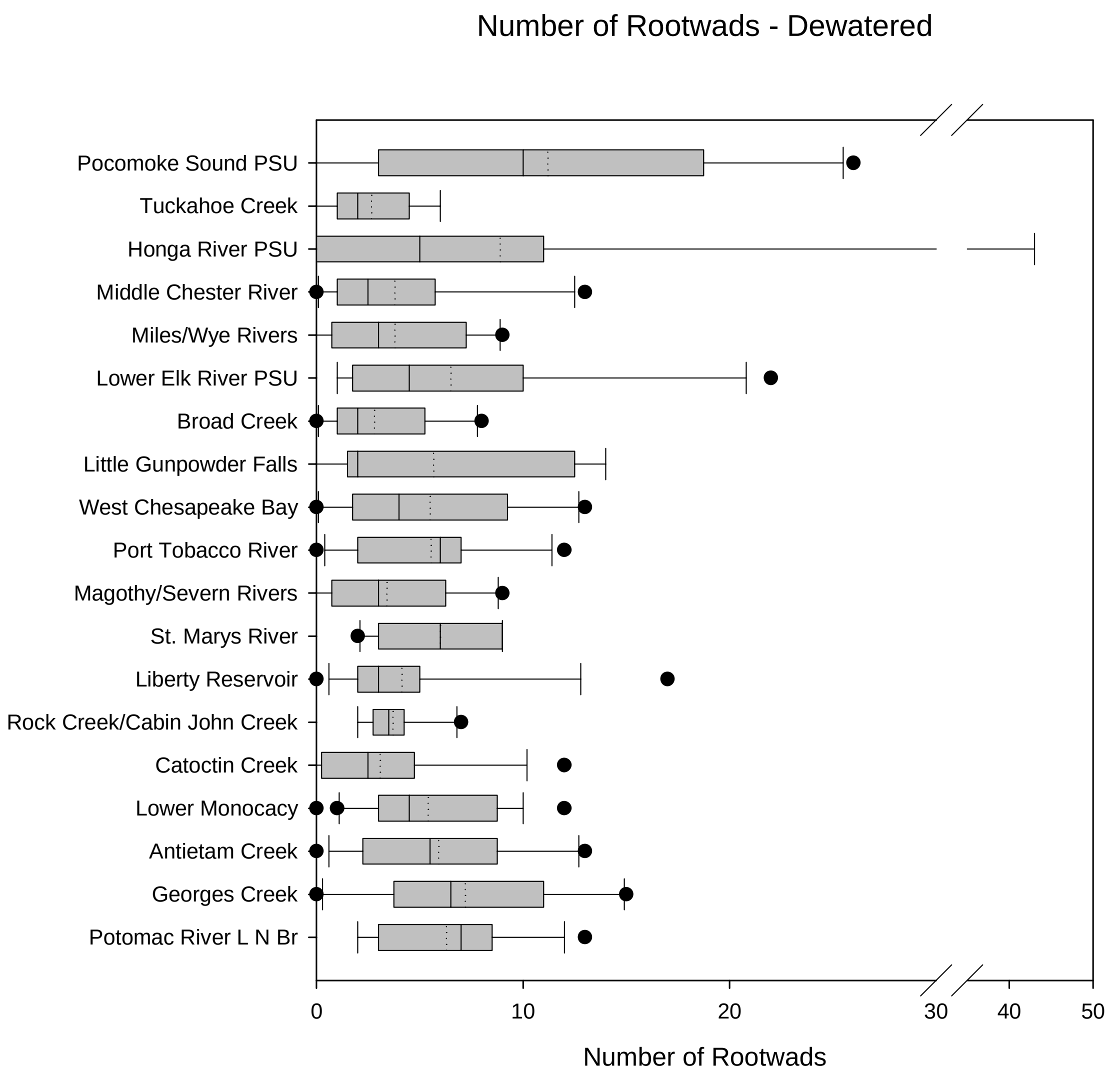

Figure 3-31. Distribution of the number of dewatered rootwads per 75 m segment for the MBSS PSUs sampled in 2003

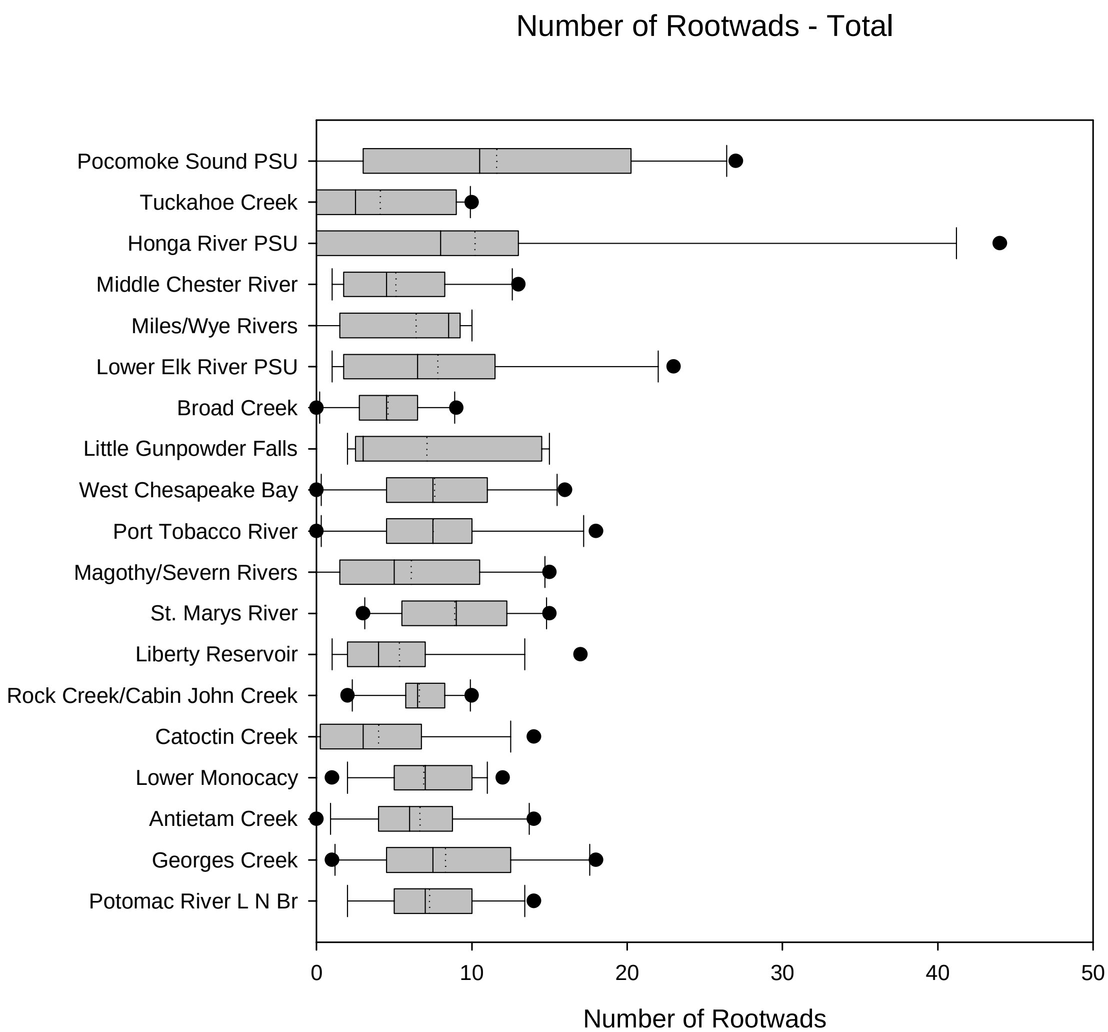

Figure 3-32. Distribution of the total number of instream rootwads and dewatered per 75 m segment for the MBSS PSUs sampled in 2003

agricultural runoff, wastewater discharge, urban/suburban nonpoint sources, and atmospheric deposition.

Excessive nitrogen and phosphorus loading may lead to eutrophication, particularly in downstream estuaries. Eutrophication often decreases the level of dissolved oxygen available to aquatic organisms. Even relatively short exposure to low dissolved oxygen levels can suffocate biota or lead to altered biological communities. Increased nutrient loads can also be harmful to humans by causing toxic algal blooms and contributing to outbreaks of organisms such as *Pfiesteria piscicida*. In Maryland, concern for nutrient loadings to the Chesapeake Bay has drawn attention to the amounts of materials transported from throughout the watershed by tributary streams.

The Survey provides a large dataset that can be used to assess nutrient concentrations under spring baseflow conditions in headwater streams. Although a full understanding of nutrient loadings also requires data collected during storm runoff events and over time (i.e., taken over multiple years and seasons), the Survey's water chemistry results provide extensive spatial coverage and a useful picture of where nutrient levels are high.

In addition to various nitrogen and phosphorus measures, the Survey assesses dissolved oxygen (DO), turbidity, sulfate (as an indicator of AMD), chloride (an indicator of general anthropogenic disturbance), and dissolved organic carbon (DOC). Key results are summarized below. Where possible, results are compared with threshold levels likely to indicate human influence (Roth et al. 1999 and R. Morgan, personal communication, 2001). To illustrate the potential degree of human impact, many figures referenced below show data in relation to these thresholds, depicted in graphs by a vertical dotted line.

3.4.1 Nutrients

Total nitrogen concentrations tended to be highest on the Eastern Shore (Figures 3-35 and 3-36). In general, nitrate nitrogen (Figure 3-37) made up the largest fraction of total nitrogen. Nitrite nitrogen was higher in Central Maryland and the Eastern Shore than elsewhere in Maryland (Figure 3-38). As expected, ammonia, often associated with agriculture, was highest in Port Tobacco River, a highly agricultural watershed (Figure 3-39). Appendix Tables B-26 to B-29 detail these results by PSU.

Nitrate nitrogen concentrations greater than 1 mg/L are commonly considered to indicate anthropogenic influence. This is more than ten-fold higher than the concentration of 0.08 mg/L recently reported for streams in undisturbed watersheds (Clark et al. 2000). Mean nitrate nitrogen concentrations in 12 of the 19 PSUs sampled in 2003 exceeded 1 mg/L. Estimates of the percentage of stream miles with nitrate nitrogen > 1 mg/L by PSU dramatically illustrate the extent of elevated nitrate levels, especially in Central Maryland and the Eastern shore (Figure 3-40, Appendix Table B-30). In several PSUs, 100% of stream miles have high nitrate nitrogen concentrations.

Total phosphorus tended to be substantially higher on the Eastern Shore, lower in Western Maryland, and moderate in the central part of the state (Figures 3-41 and 3-42). Results for orthophosphate share a similar pattern and are shown in Figure 3-43. Appendix Tables B-31 and B-32 detail these results by PSU.

3.4.2 Other Water Quality Parameters

Dissolved oxygen concentrations at most locations were greater than 5 mg/L, the COMAR standard and a level generally considered healthy for aquatic life (Figure 3-44, Appendix Table B-33). Two PSUs had a mean DO < 5 mg/L – the Honga River PSU and the Pocomoke Sound PSU. Individual sites with low DO should be examined for natural contributing factors causes such as low gradient, blackwater conditions that make the streams particularly susceptible to BOD loading from anthropogenic sources. Estimates of the percentage of stream miles with low DO are given in Figure 3-45 (Appendix Table B-34). Seasonal monitoring of streams suspected to have low DO problems and examination of watershed factors would help to diagnose situations where the problem is persistent and can be linked to anthropogenic causes.

As expected (because sampling generally is done when water clarity is good), turbidity was generally low and best represent near baselfow conditions (Figure 3-46, Appendix Table B-35). The Lower Elk River PSU had one site with a turbidity value near 1000 NTUs. A more complete characterization of turbidity in a given stream would require monitoring during storm events.

Sulfate values were not generally high (Figure 3-47, Appendix Table B-36), although many PSUs had maximum values greater than the 30 mg/L threshold established for anthropogenic disturbance. PSUs in Western Maryland such as Georges Creek and Antietam Creek each had some sites with elevated sulfate values, although these values could not be primarily attributed to Acid Mine Drainage. Georges Creek had the highest mean sulfate concentration (63 mg/L).

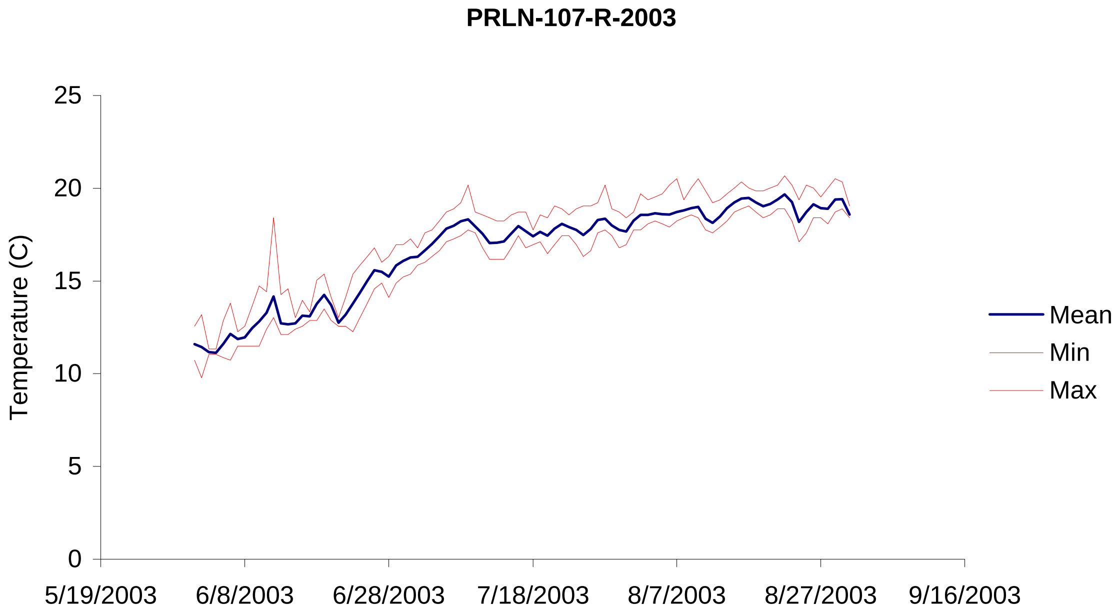

Figure 3-33. Mean, minimum and maximum daily temperatures (degrees Celsius) for a stream sampled in MBSS 2003, PRLN-107-R-2003. Period of record was from June 1, 2003 to August 31, 2003.

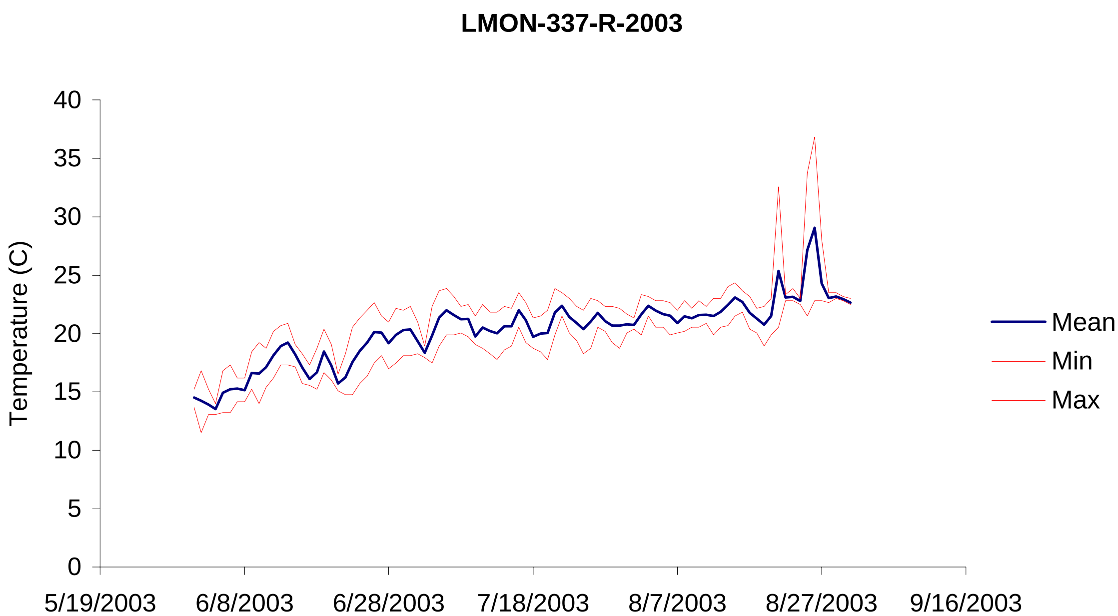

Figure 3-34. Mean, minimum and maximum daily temperatures (degrees Celsius) for a stream sampled in MBSS 2003, LMON-357-R-2003. Period of record was from June 1, 2003 to August 31, 2003.

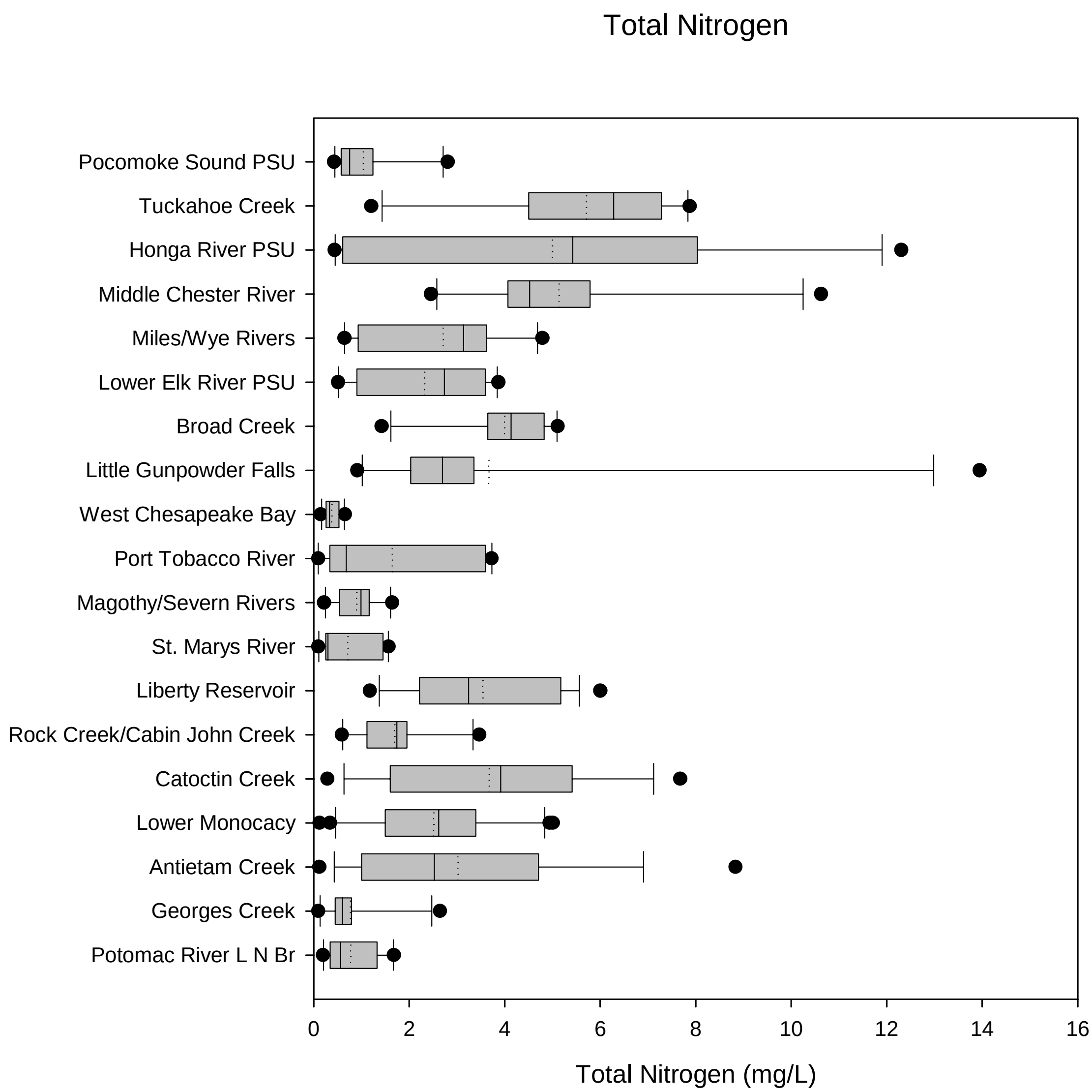

Figure 3-35. Distribution of total nitrogen values (mg/L) for the MBSS PSUs sampled in 2003

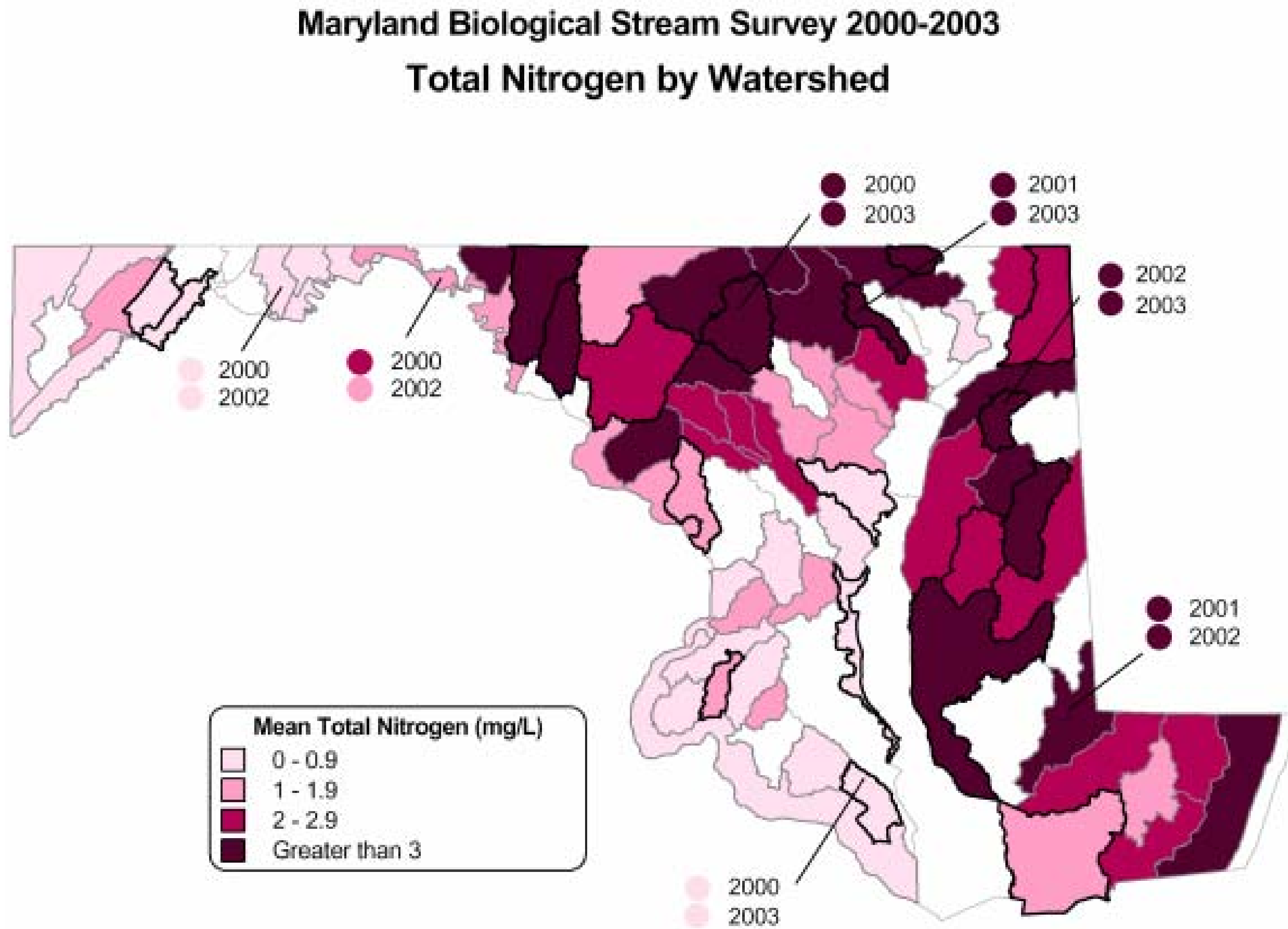

Figure 3-36. Distribution of total nitrogen values (mg/L) for the MBSS PSUs sampled in 2000, 2001, 2002, and 2003. PSUs sampled in 2002 have bolder outlines than those sampled in 2000 -2002. Five PSUs that were sampled in previous years were also sampled in 2003.

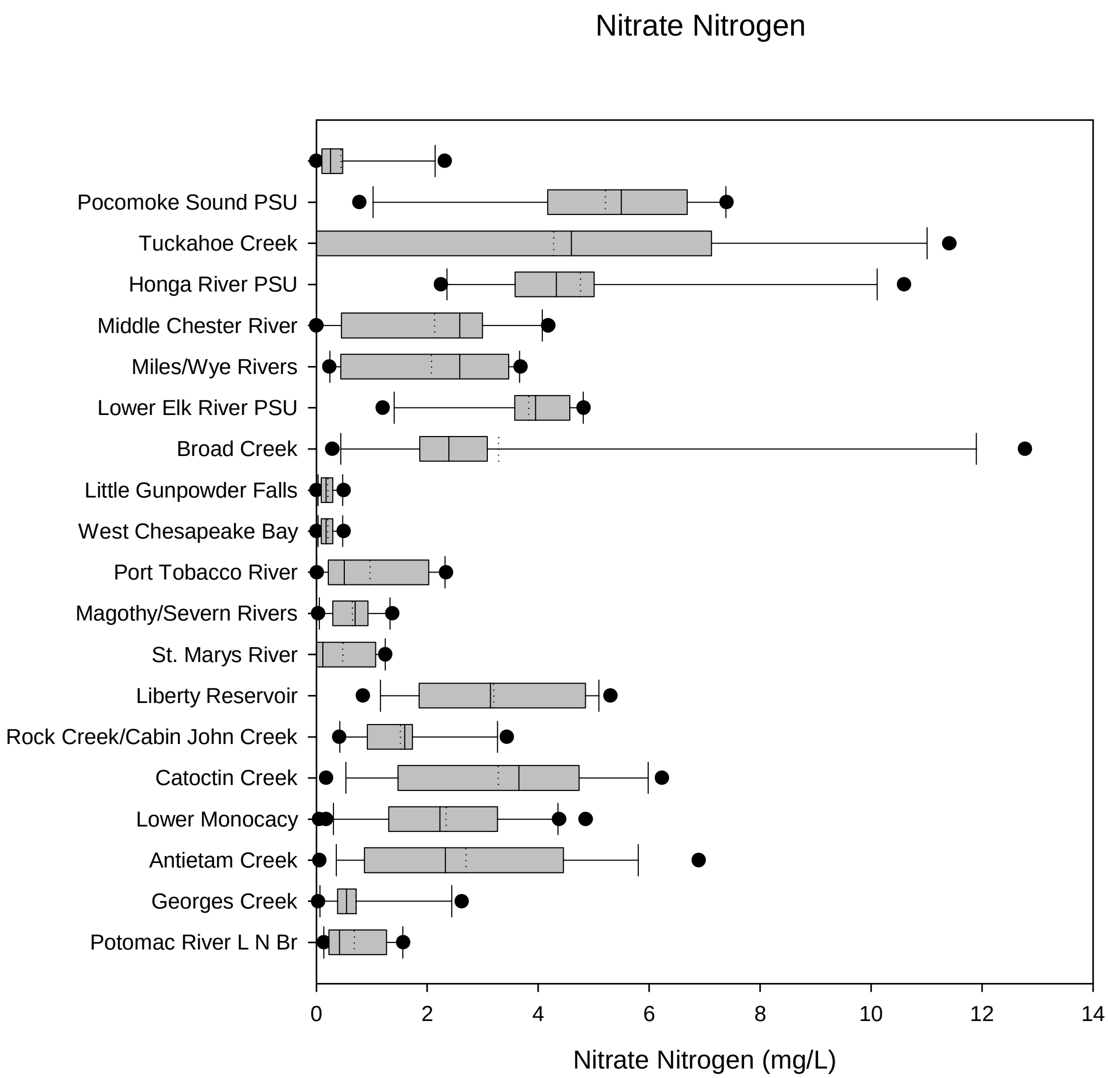

Figure 3-37. Distribution of nitrate nitrogen values (mg/L) for the MBSS PSUs sampled in 2003

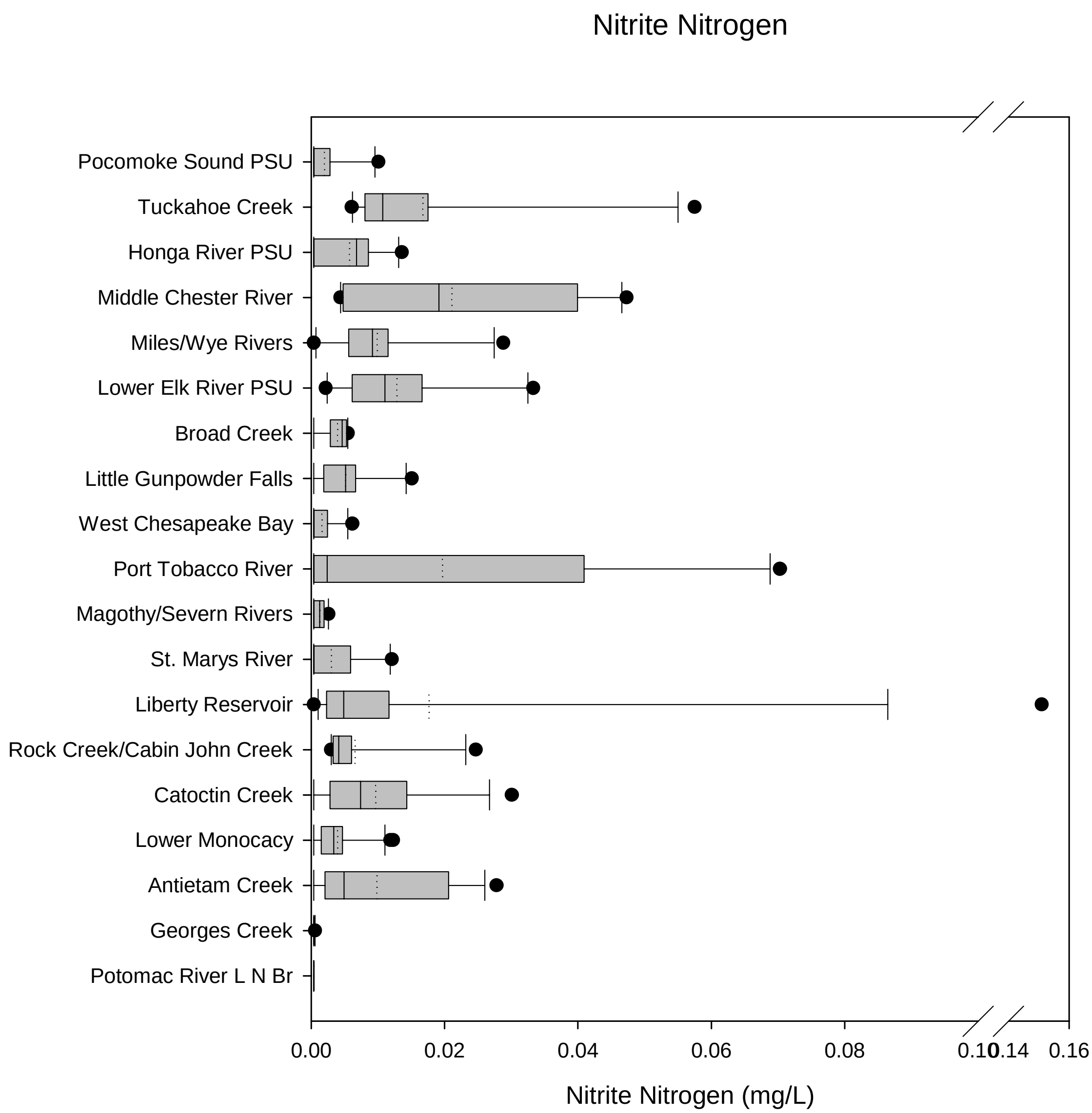

Figure 3-38. Distribution of nitrite nitrogen values (mg/L) for the MBSS PSUs sampled in 2003

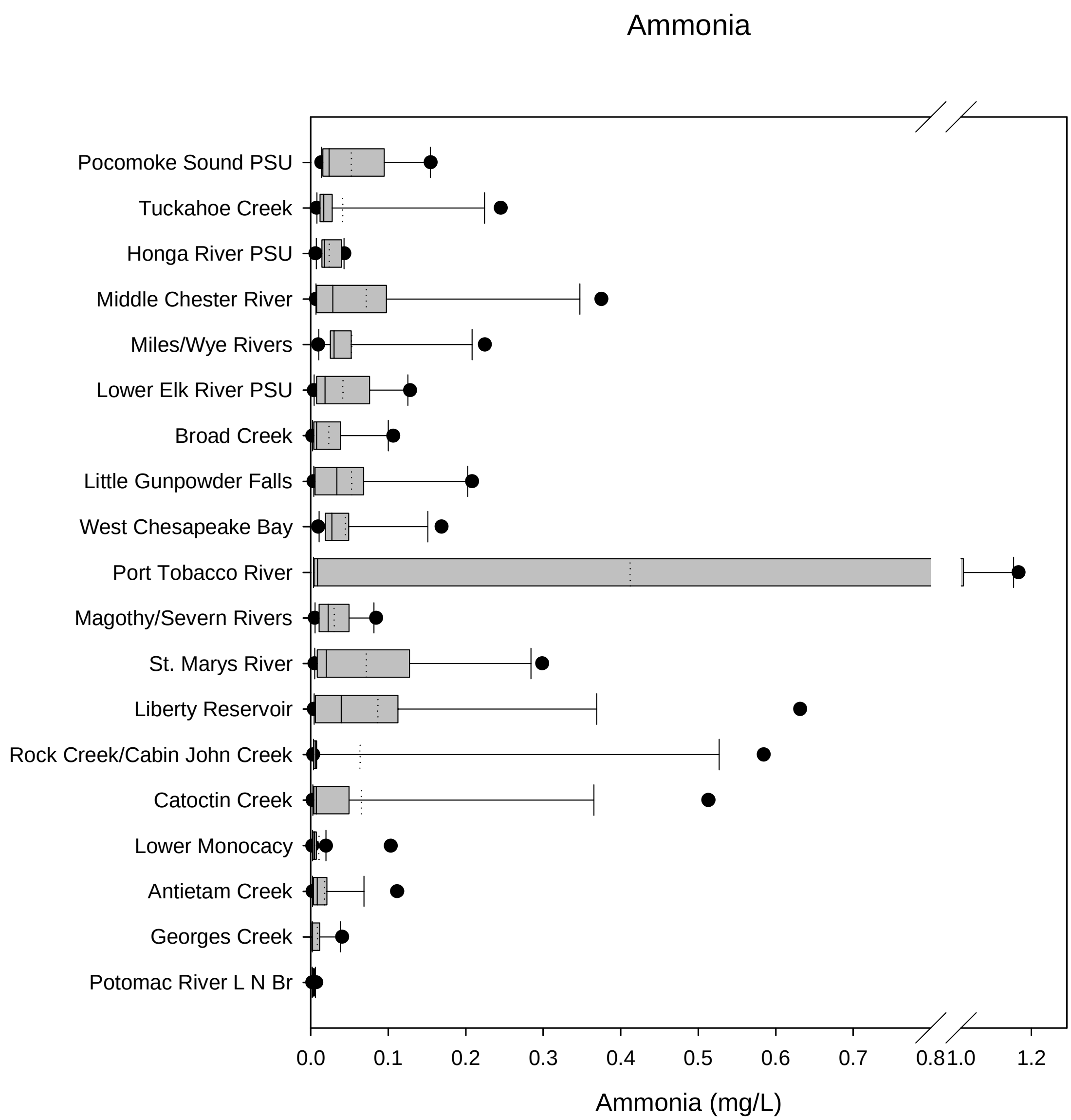

Figure 3-39. Distribution of ammonia values (mg/L) for the MBSS PSUs sampled in 2003

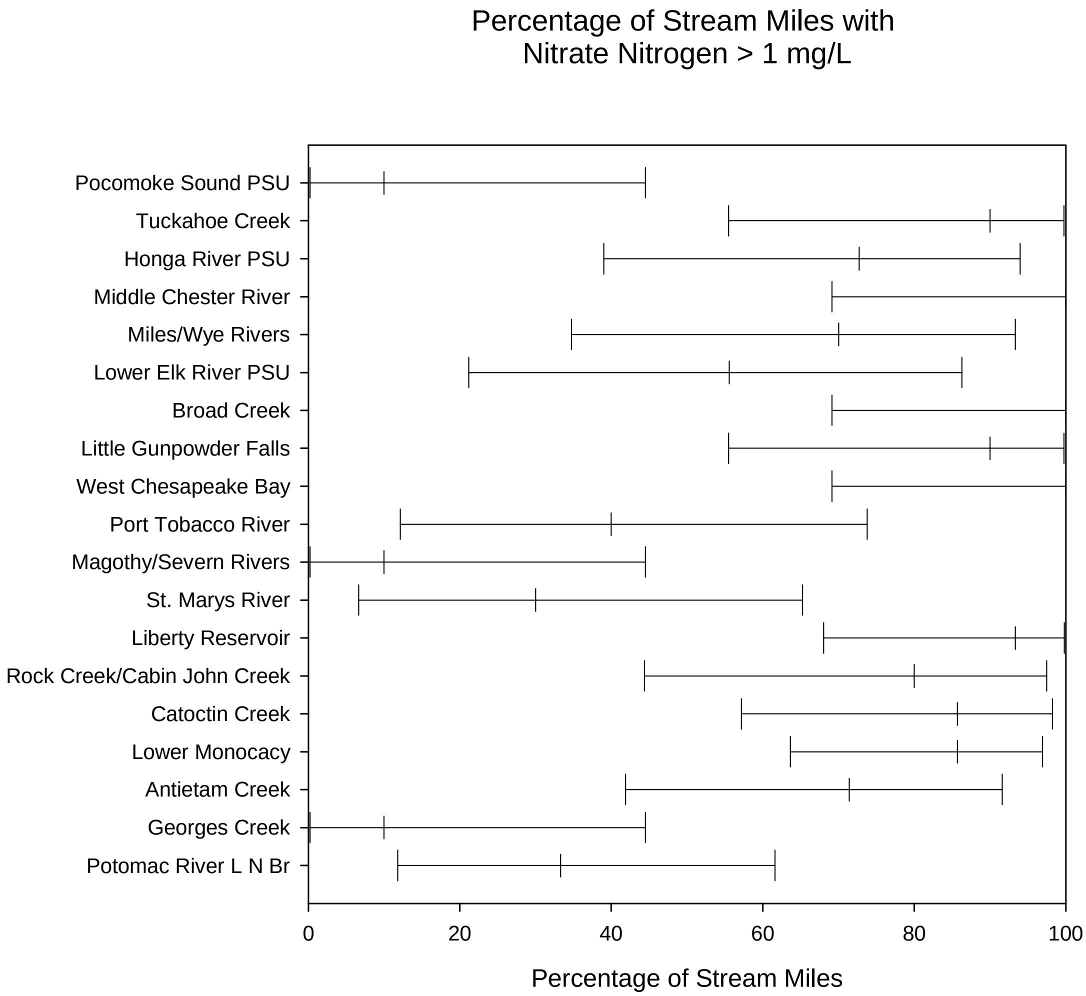

Figure 3-40. Percentage of stream miles with nitrate-nitrogen greater than 1.0 mg/L for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

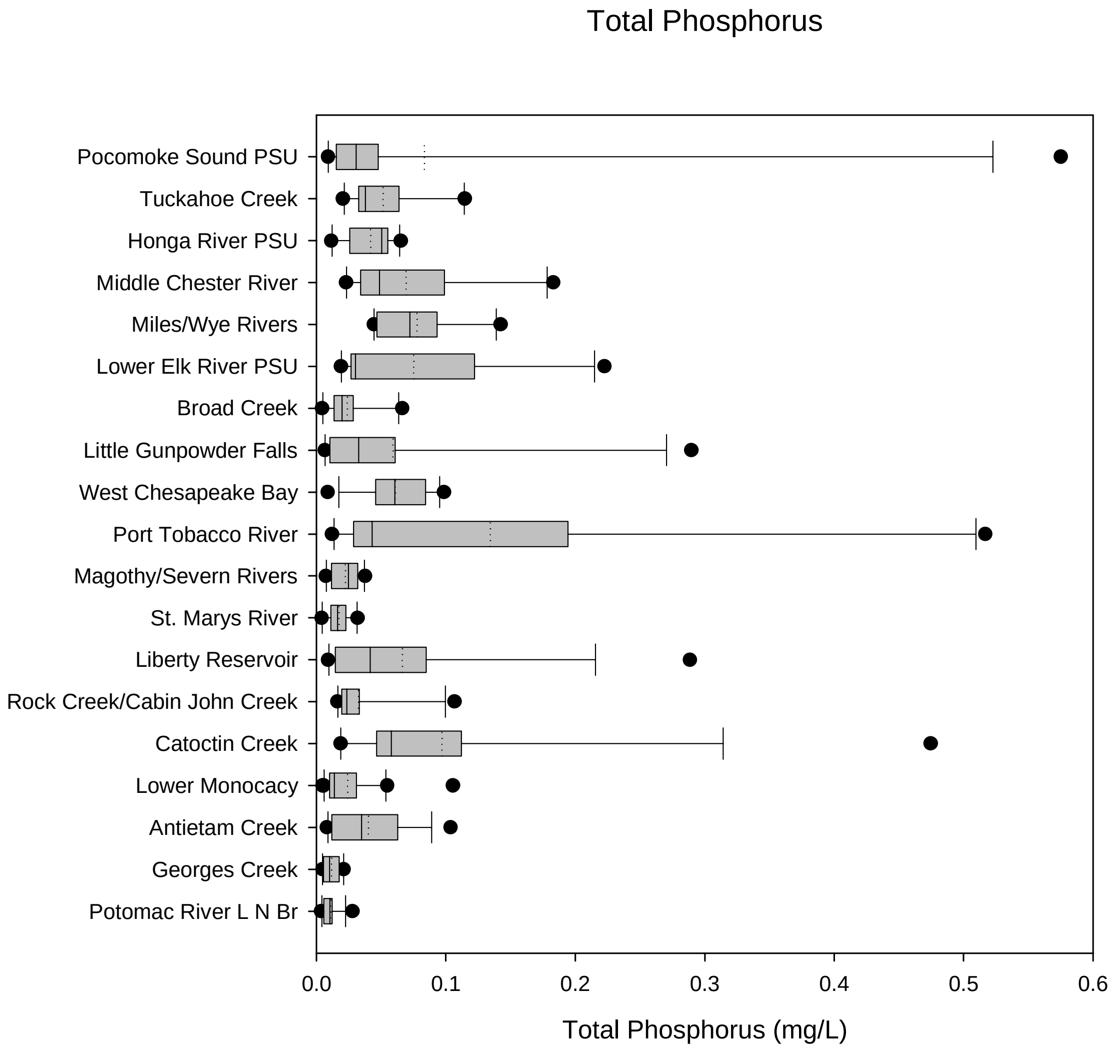

Figure 3-41. Distribution of total phosphorus values (mg/L) for the MBSS PSUs sampled in 2003

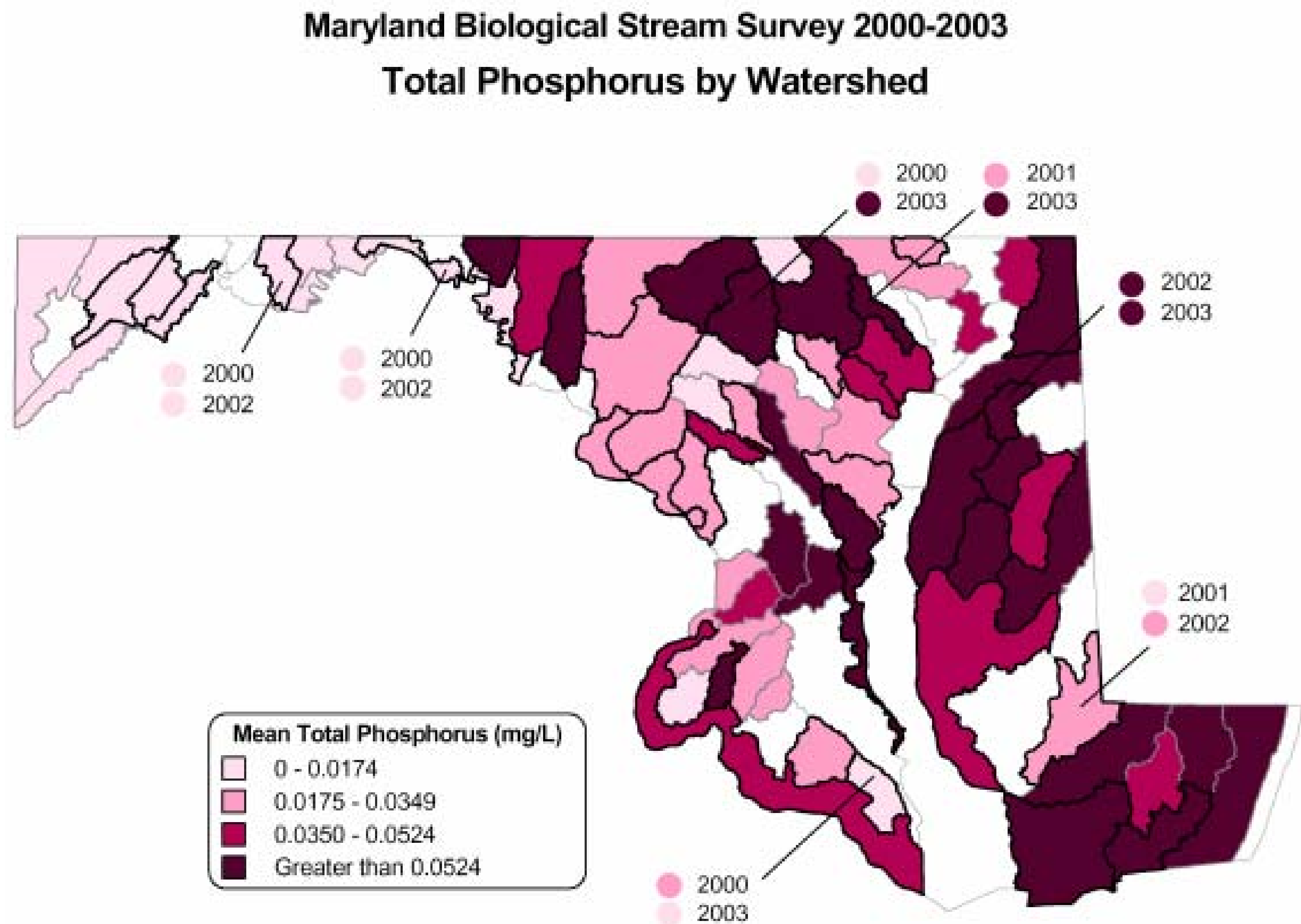

Figure 3-42. Distribution of total phosphorus values (mg/L) for the MBSS PSUs sampled in 2002 and 2003. PSUs sampled in 2003 have bolder outlines than those sampled in 2000-2002. Five PSUs that were sampled in previous years were also sampled in 2003.

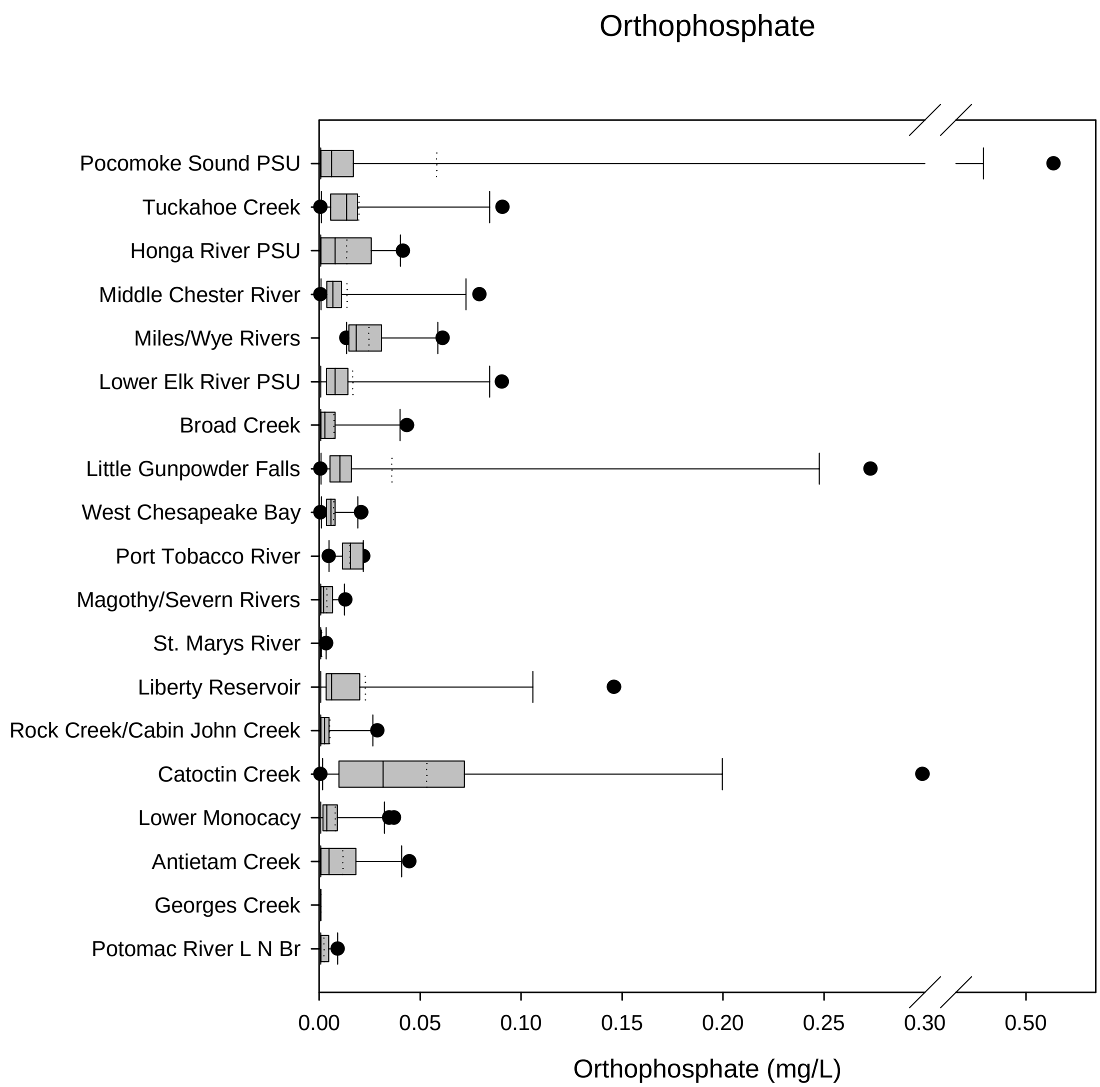

Figure 3-43. Distribution of orthophosphate values (mg/L) for the MBSS PSUs sampled in 2003

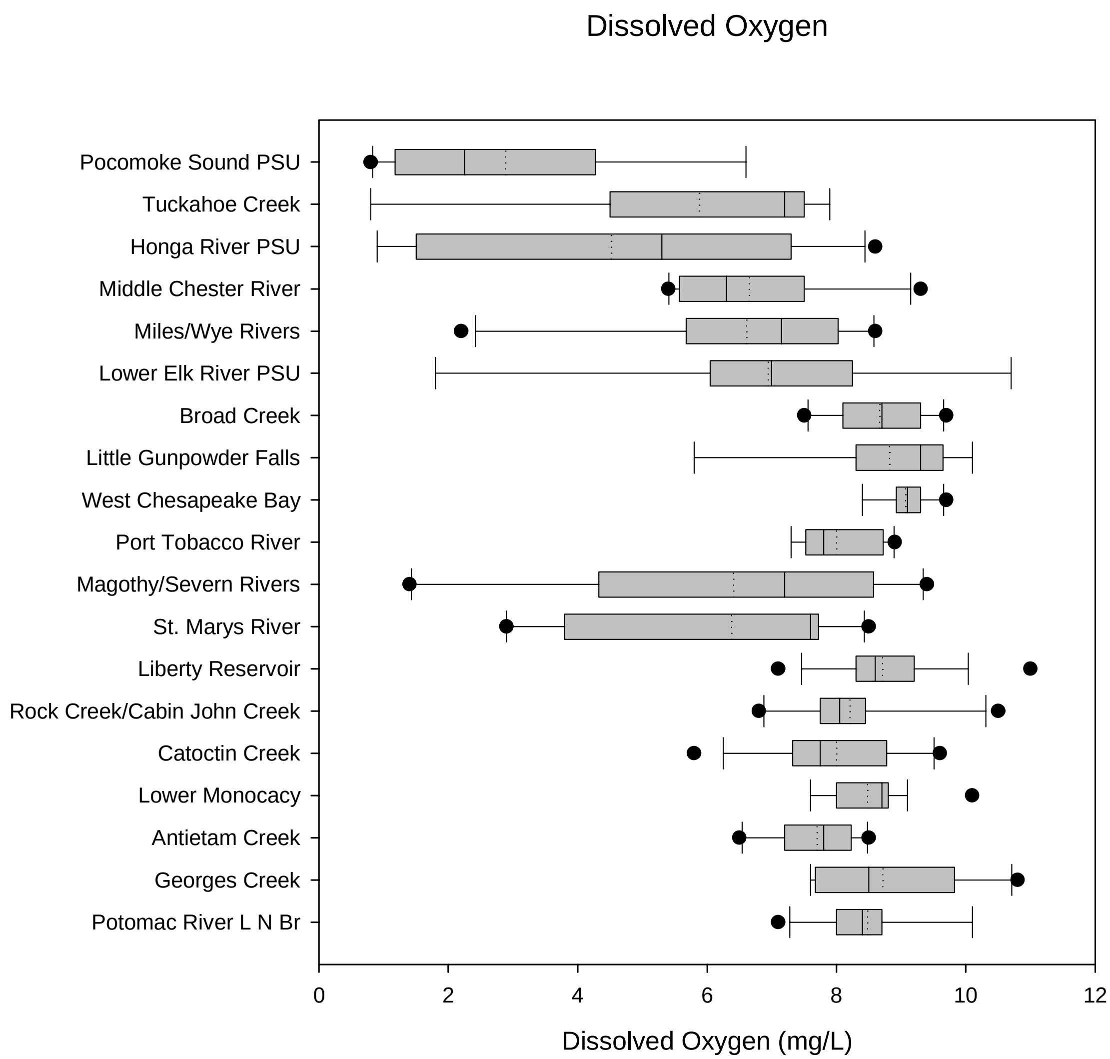

Figure 3-44. Distribution of dissolved oxygen concentrations (mg/L) for the MBSS PSUs sampled in 2003

Chloride (Figure 3-48 , Appendix Table B-37) tended to highest in the urban areas - especially in Central Maryland. The sites in these PSUs have a higher probability of being located close to roads where high chloride levels may be the result of salt application during winter months.

As expected, mean dissolved organic carbon (DOC; Figure 3-49, Appendix Table B-38) was highest in Coastal Plain basins, especially on the Eastern Shore, where blackwater stream conditions are most prevalent.

3.5 LAND USE

A measure of anthropogenic influence at the landscape scale is watershed land use. Watersheds form natural geographic units for assessing impacts on streams, because land use within the watershed (or catchment) upstream of a specific stream site is representative of many of the human activities affecting the stream at that point. As such, land cover serves as a surrogate for a variety of stressors.

In much of the United States, conversions of naturally vegetated watershed lands to urban and agricultural uses have resulted in serious impacts to streams and their aqutic inhabitants. Some investigations have indicated that development of even small portions of the watershed area can have detrimental effects on streams (Schueler 1994). Impervious surfaces, such as roads, parking lots, sidewalks, and rooftops, cause a rapid increase in the rate at which water is transported from the watershed to its stream channels. Effects include more variable stream flows, increased erosion from runoff, habitat degradation caused by channel instability, increased nonpoint source pollutant loading, elevated temperatures, and losses of biological diversity.

Reviews of stream research in numerous watersheds (Center for Watershed Protection 1998, Schueler 1994) indicate that impacts on stream quality are commonly noted at about 10% coverage by impervious surface. Effects on sensitive species may occur at even lower levels. With even more impervious surface, most notably, at about 25-30% of catchment area, studies have shown that numerous aspects of stream quality become degraded, including biological integrity, water quality, and physical habitat quality (Center for Watershed Protection 1998).

Of the 20 PSUs sampled in 2003, the greatest amounts of urban land occurred in PSUs located in the central portion of the state (Figure 3-50, Appendix Table B-39). The Magothy/Severn River PSU had the highest mean percentage of urban land use in upstream catchments (27%), while Rock Creek/Cabin John Creeks and Port Tobacco River also had sites with greater than 50% urban land use. PSUs in western Maryland and on the Eastern Shore had much smaller percentages of urban land in catchments upstream of MBSS sites. The percentage of impervious surface (calculated as 75% of the value for high density urban land use plus 25% of the value for low density urban land use) followed the patterns show in the percentage of urban land use.

The greatest amounts of agricultural land uses in upstream catchments occurred in PSUs sampled on the Eastern Shore and in several PSUs in central Maryland (Figure 3-51, Appendix Table B-40). Middle Chester River had the highest mean agricultural land use (88%).

Western Maryland contains the PSUs with the largest amounts of forested land use in the state (Figure 3-52, Appendix Table B-41). Potomac River Lower North Branch had the largest mean percentage of forest land use in upstream catchments (96%, including four sites with 100% forested land use in the upstream catchment). Georges Creek had the next largest percentage of forested land use in upstream catchments (92%), followed by two watersheds further east – West Chesapeake Bay (77%) and Pocomoke Sound (73%).

3.6 EXPLORATORY STRESSOR ANALYSIS

During 2003, Maryland DNR analyzed MBSS data in conjunction with information from three other programs to identify possible new methods for stressor identification. First, MBSS data from 1995 through 2002 were used to develop a method for identifying sediment impairments under MDE's Total Maximum Daily Load (TMDL) program. In addition, MBSS data from streams with potential water withdrawals were analyzed as part of an investigation into low flow effects. Lastly, MBSS data were combined with Stream Corridor Assessment data (collected by a separate Maryland DNR program) in selected watersheds to see if a better picture of watershed problems could be revealed. The sediment analysis is being adopted by MDE, while the other analyses remain preliminary. All three analyses produced recommendations for further research into stressor identification methods.

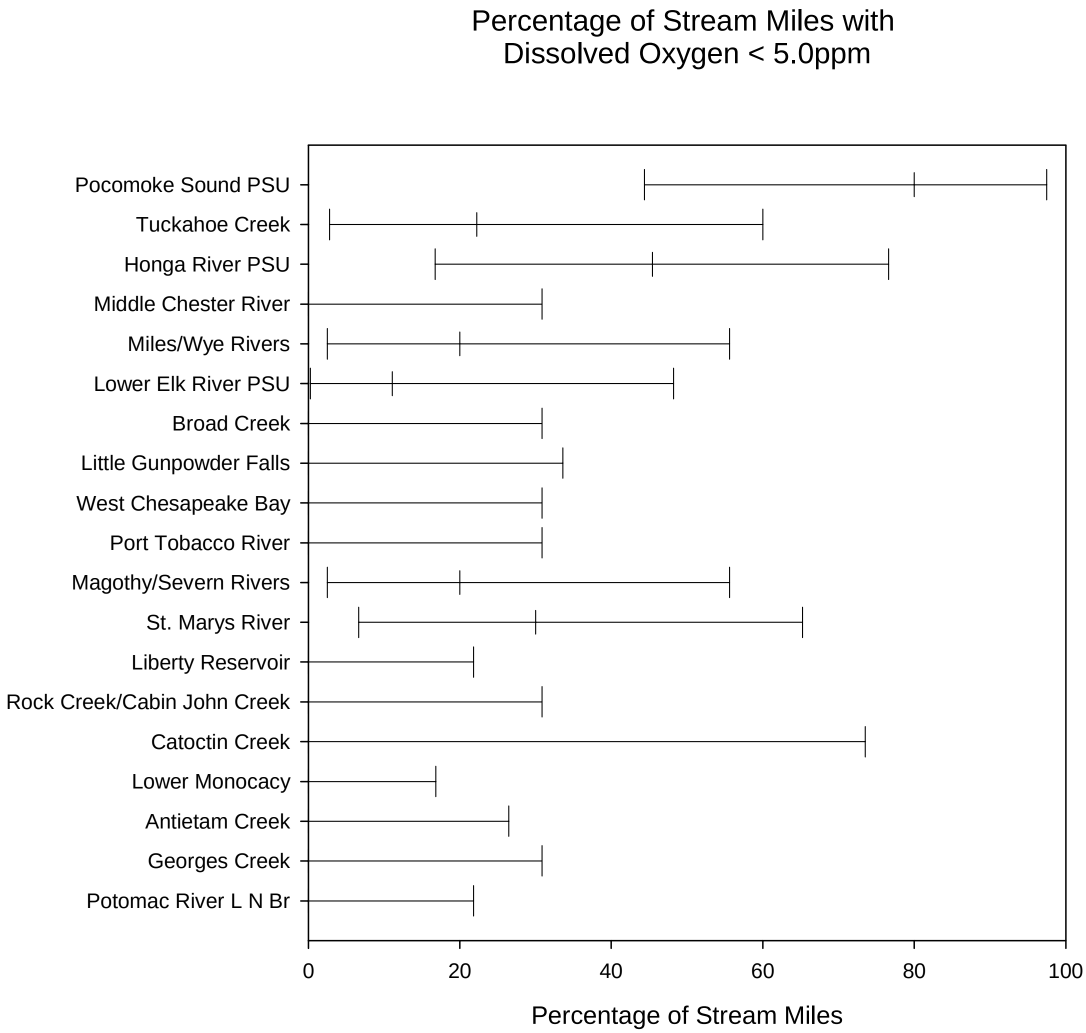

Figure 3-45. Percentage of stream miles with dissolved oxygen concentrations < 5.0 mg/L for the MBSS PSUs sampled in 2003 (with 90% confidence intervals)

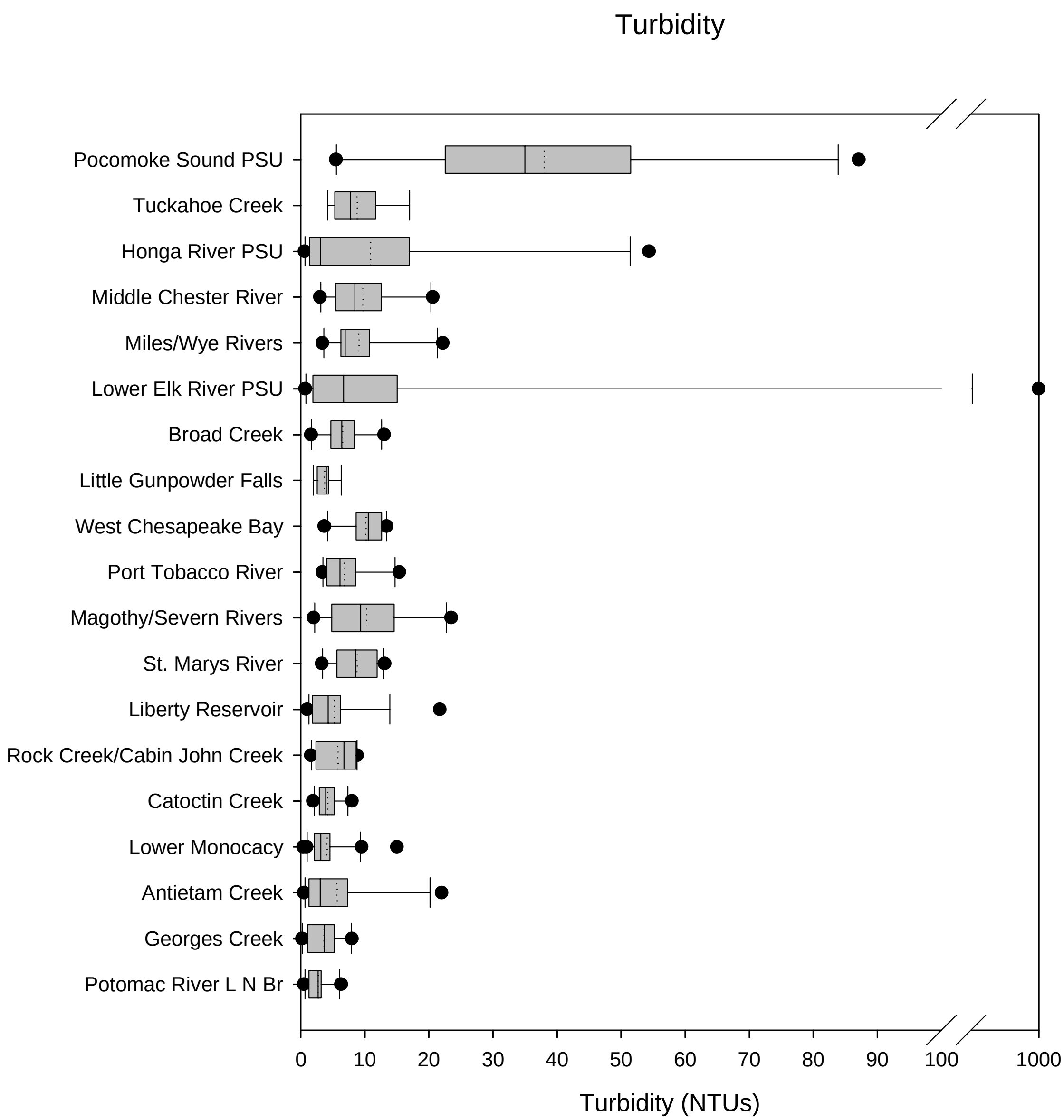

Figure 3-46. Distribution of turbidity values (NTUs) for the MBSS PSUs sampled in 2003.

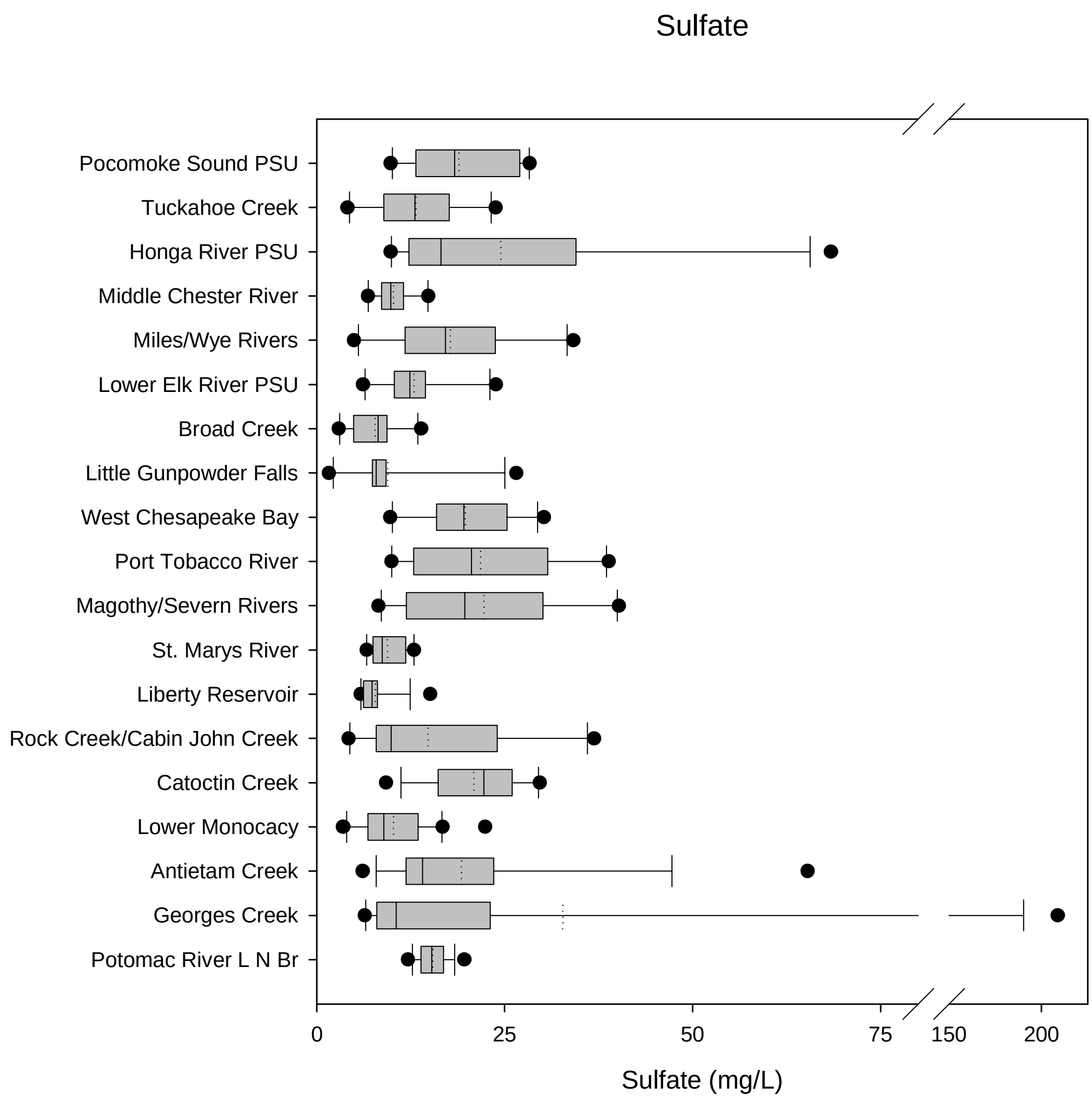

Figure 3-47. Distribution of sulfate values (mg/L) for the MBSS PSUs sampled in 2003.

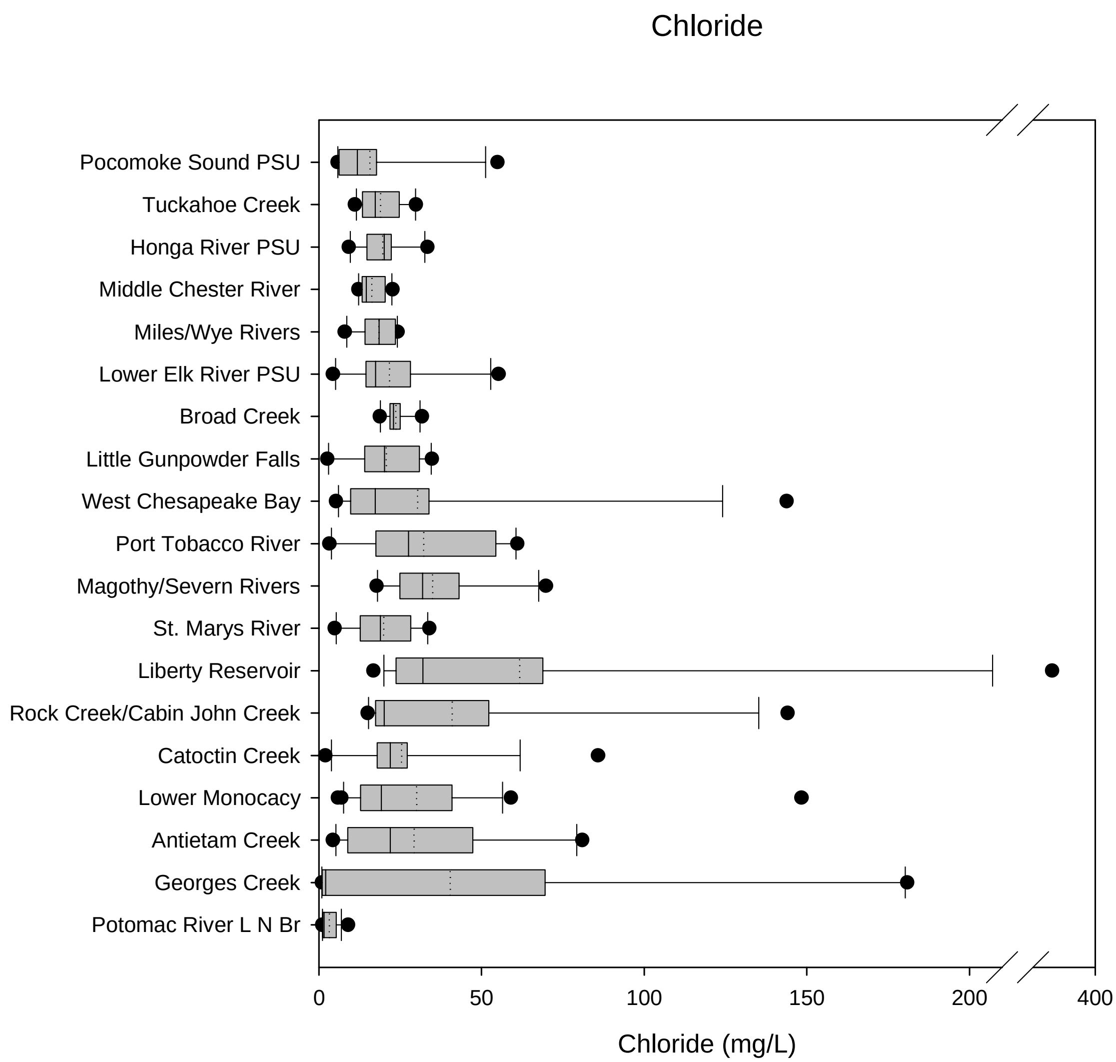

Figure 3-48. Distribution of chloride values (mg/L) for the MBSS PSUs sampled in 2003.

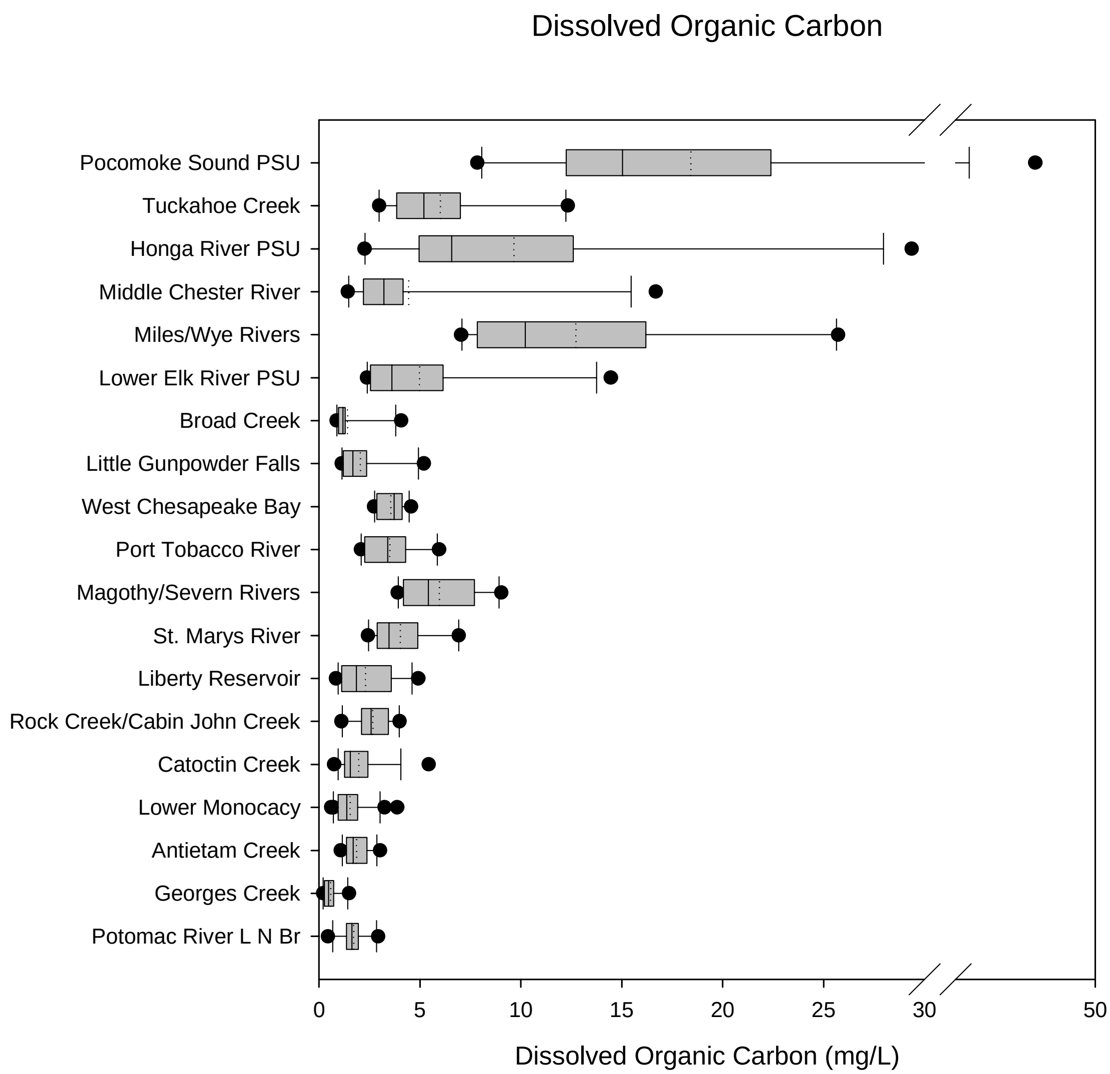

Figure 3-49. Distribution of dissolved organic carbon values (mg/L) for the MBSS PSUs sampled in 2003.

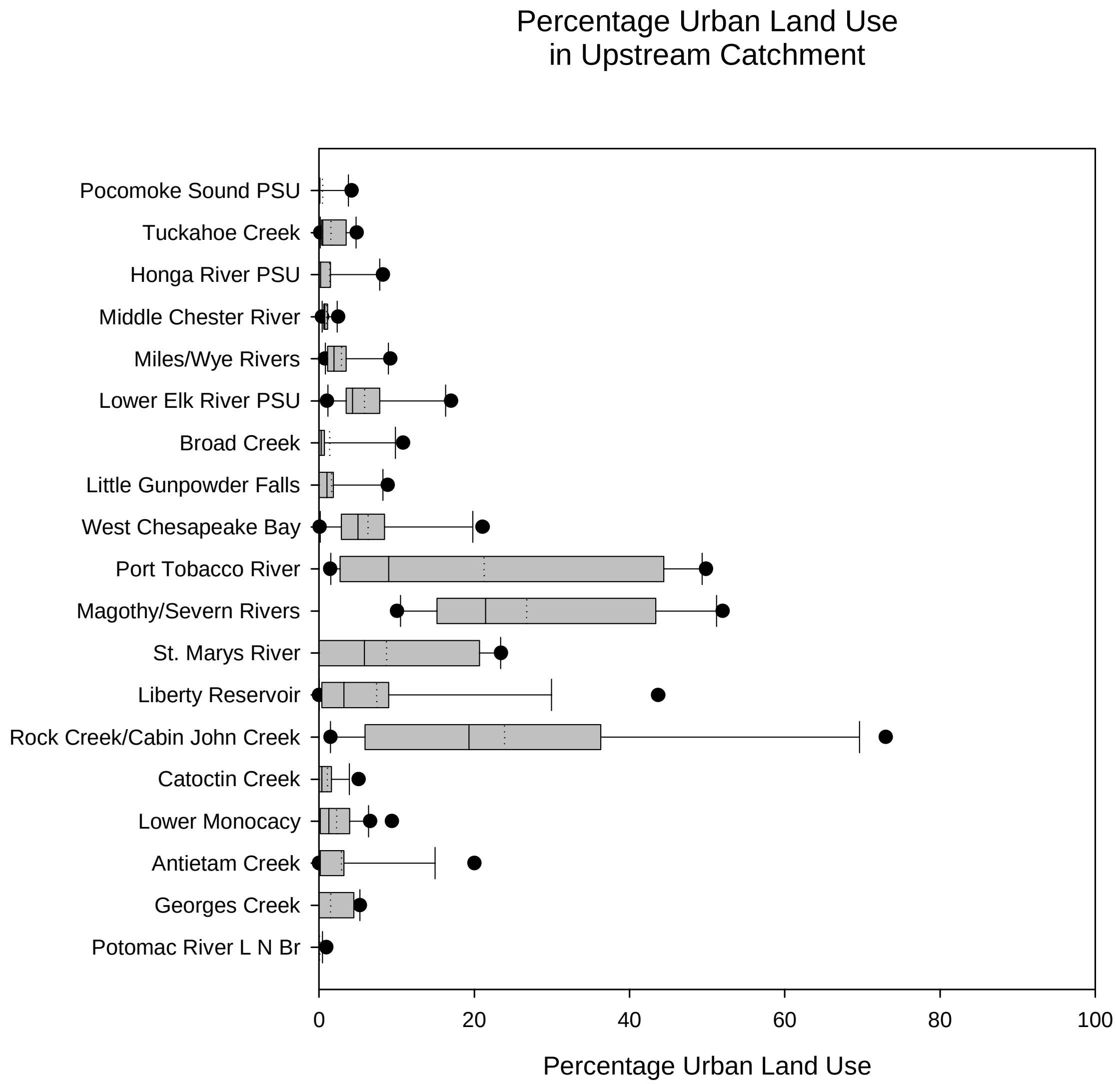

Figure 3-50. Distribution of the percentage of urban land in the catchments upstream of the MBSS 2003 sites

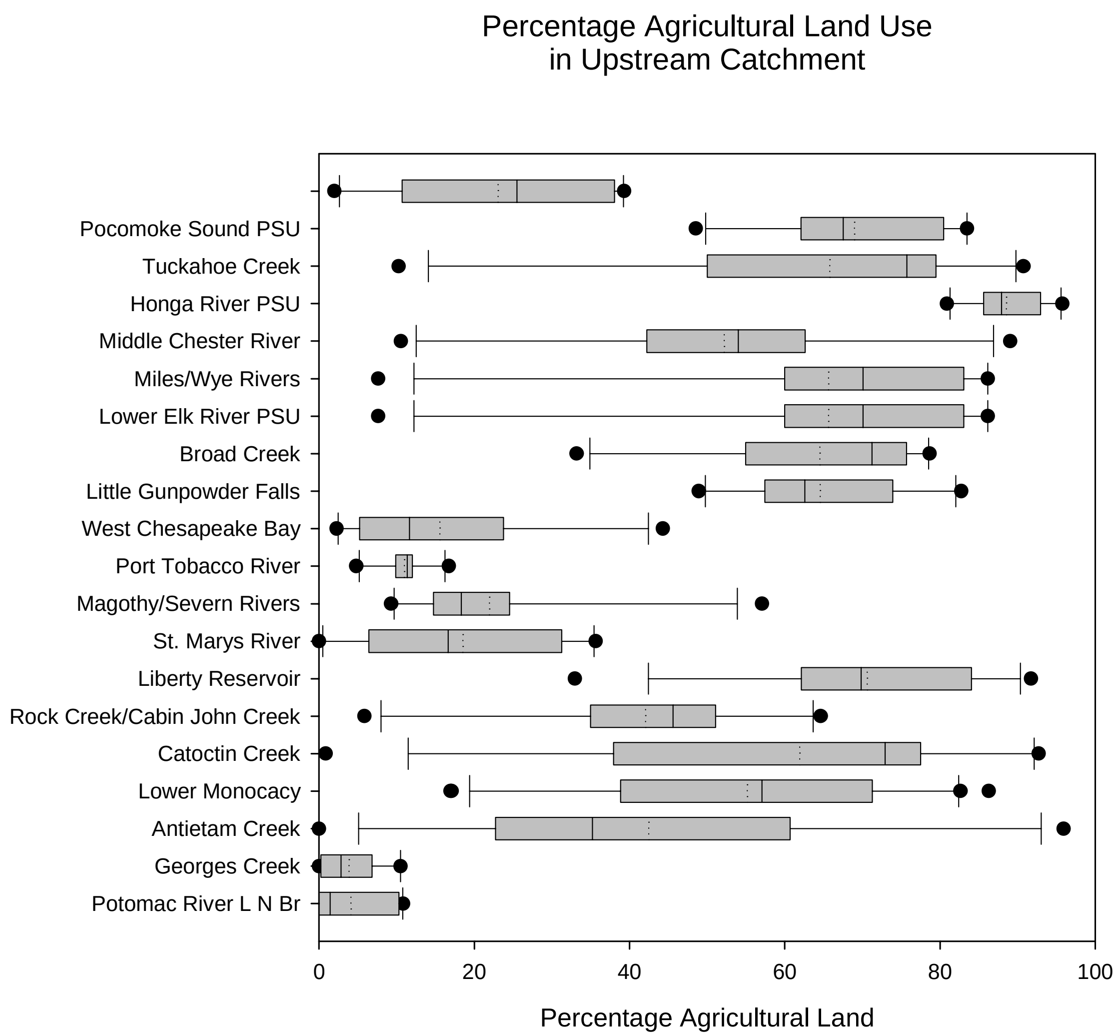

Figure 3-51. Distribution of the percentage of agricultural land in the catchments upstream of the MBSS 2003 sites

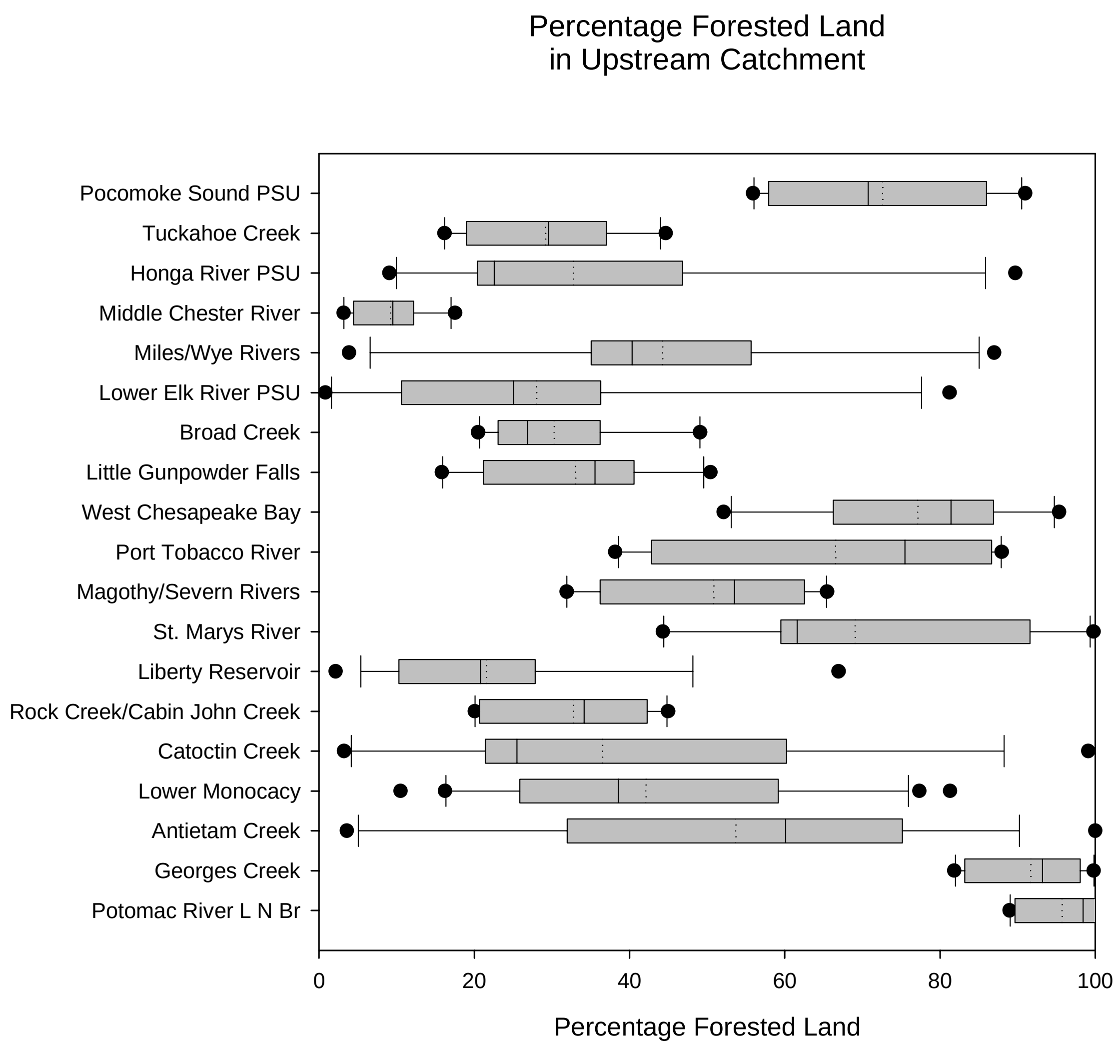

Figure 3-52. Distribution of the percentage of forested land in the catchments upstream of the MBSS 2003 sites

3.6.1 Sediment Impairments

The Maryland Department of the Environment (MDE) collaborated with Maryland DNR to develop a method for identifying sediment impairment in Maryland watersheds based on MBSS data (Southerland et al. 2004). Specifically, MBSS data from 1995 to 2002 were combined with additional landscape information from Maryland Department of Planning (MDP) to identify likely sediment impairments based on sediment-related stream habitat endpoints. This endpoint approach is consistent with U.S. Environmental Protection Agency (EPA) guidelines and uses Maryland biocriteria-based, water quality standards (Figure 3-53).

To develop a model of sediment effects, the project first identified candidate MBSS physical habitat parameters potentially influenced by sediment transport (the most promising of the 17 tested variables are shown in Table 3-3). Next, MBSS monitoring sites that were affected by known, non-sediment related stressors (urban land use, high chloride levels, and acidification) were removed from the dataset. Lastly, statistical techniques, including linear and logistic regression, were used to develop the best model (sediment indicator) for identifying sediment-related effects on biocriteria failure (degraded biological communities as represented by fish and benthic IBI scores).

MDE is evaluating different options for applying this sediment indicator at the Maryland 8-digit watershed or other spatial scales. This report recommends that a statewide model that incorporates regional effects (for Highlands, Eastern Piedmont, and Coastal Plain) be used to identify 8-digit watersheds likely to be altered (degraded) by sediment. This "regionalized, statewide sediment indicator" includes the following parameters: embeddedness, riparian buffer width, instream habitat, and the interactions of embeddedness*Coastal Plain and embeddedness*Highlands (Table 3-4). The indicator has a model concordance (percentage of sites correctly predicting biological condition) of 74.5%.

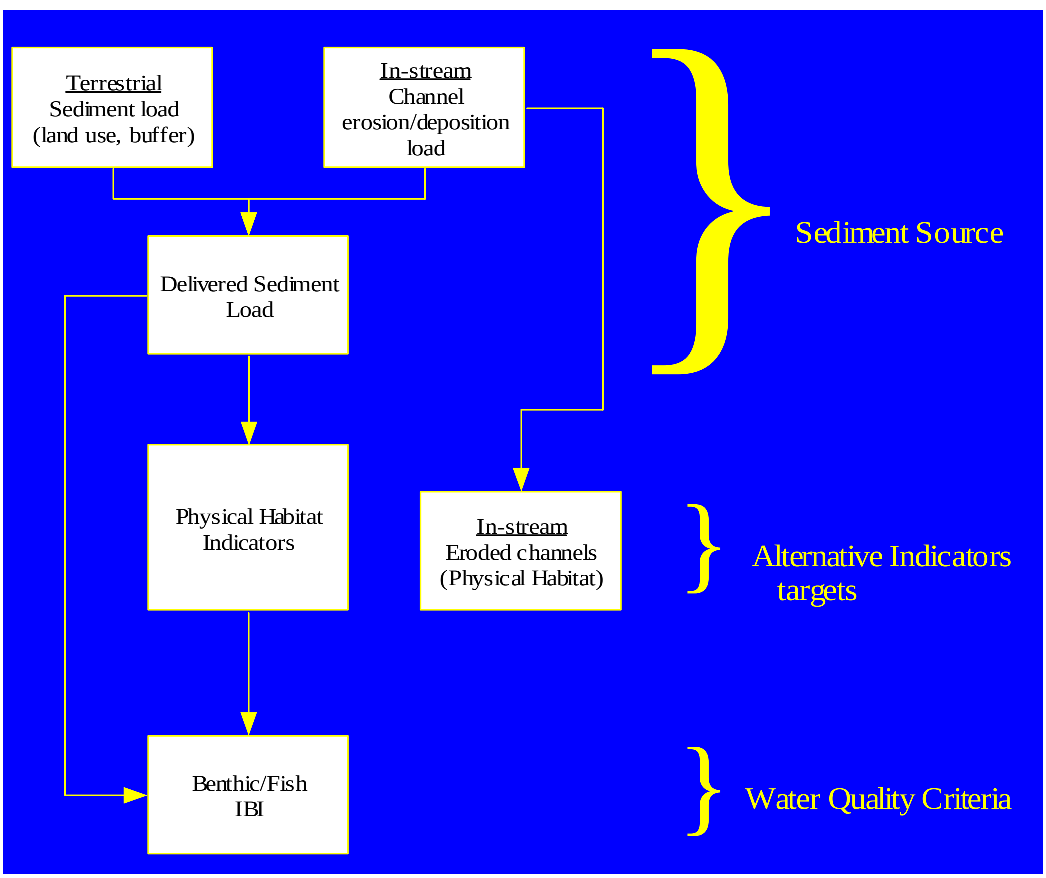

Figure 3-53. MDE approach to developing sediment TMDLs

Table 3-3. Five candidate variables with identified relationships to sediment that may serve as useful surrogates for predicting stream impairment.			
Surrogate Variables	**Definition**	**Scoring**	**Relationship to Sediment**
Bank stability (and proxy from bank erosion variables)	Composite score combining visual rating based on the presence or absence of riparian vegetation and other stabilizing bank materials, such as boulders and rootwads, with quantitative measures of erosion extent and erosion severity.	0 to 100	Bank stability is evidence of lack of channel erosion, a major source of downstream sediment transport. Sediment loading may still occur through overland runoff.
Embeddedness	Percentage of gravel, cobble, and boulder particles in the stream bed that are surrounded by fine sediment.	0 to 100	High embeddedness is direct evidence of sediment deposition. However, embeddedness is confounded by natural variability (e.g., Coastal Plain streams will naturally have more embeddedness than Highlands streams).
Instream habitat	Visual rating based on the perceived value of instream habitat to the fish community, including multiple habitat types, varied particle sizes, and uneven stream bottom.	0 to 20	High instream habitat scores are evidence of lack of sediment deposition. However, instream habitat is confounded by natural variability (i.e., some streams will naturally have more or less instream habitat).
Physical habitat indicator (PHI)	PHI is a composite index based on six metrics, the suite of which varies by region (i.e., Highlands, Piedmont, and Coastal Plain), including bank stability, embeddedness, epifaunal substrate, instream habitat structure, number of woody debris, riffle/run quality, riparian buffer width, remoteness, and shading.	0 to 100	High PHI scores indicate general lack of sedimentation, as well as other adverse effects on physical habitat. Because PHI includes each of the other surrogate variables for sediment in at least one region, it is somewhat redundant when used with those variables.
Riparian buffer width	Width of vegetated (i.e., grass, shrubs, or trees) riparian buffer, estimated to a maximum distance of 50 meters from the stream channel.	0 to 50	Wide and well-vegetated riparian buffers are indirectly related to sedimentation as buffers remove sediment in runoff and protect banks from erosion. Riparian buffers also benefit aquatic communities by reducing stream temperature through shading, an effect unrelated to sediment.

Table 3-4. Regionalized, statewide model of sediment effects (probability of failing biocriteria ($\hat{p}$) for each MBSS site) using binary, stepwise logistic regression of physical habitat variables and Highlands, Piedmont, and Coastal Plain regions.		
Parameter	**Coefficient**	**Pr>Chi Sq**
Intercept	1.1461	0.0021
EMBEDDED	-0.0012	0.7903
RIP_WID	-0.0115	0.0014
INSTRHAB	-0.1081	<0.0001
EMBEDDED*Coastal	0.0163	<0.0001
EMBEDDED*Highlands	0.0287	<0.0001

Applying the sediment indicator to watersheds involves calculating the probability of failing biocriteria ($\hat{p}$) for each MBSS site in the watershed (we recommend using only watersheds that have 10 or more MBSS sites). Next, we calculate the average and standard deviation of $\hat{p}$ for the watershed to produce a graph of confidence intervals for the average sediment indicator result. If the upper confidence interval is below the 50% probability of sediment degradation (biocriteria threshold), then the watershed has a very low likelihood of impairment due to sediment deposition (Figure 3-54). If the mean is below the biocriteria threshold, but the upper bound of the confidence interval is above, the likelihood is low. If the mean is above the biocriteria threshold, but the lower bound of the confidence interval is below, the likelihood is medium. If the lower bound of the confidence interval is above the biocriteria threshold, the likelihood is high. MDE is considering using this approach to designating sediment impairments as the foundation for a reference watershed approach to developing sediment total maximum daily loads (TMDLs).

3.6.2 Low Flow Effects

Maryland DNR is interested in the issue of low flow in Maryland streams. Specifically, Maryland DNR is investigating whether MDE's minimum flow-by requirements for surface water withdrawal permits are protecting the State's aquatic resources. It is not known whether the permits are uniformly applied or whether they consider the potential cumulative effects of other permitted withdrawals on the same waterway. The comprehensive data collected for the Maryland Biological Stream Survey (MBSS) may be a useful tool for answering the question of adverse effects, if enough water withdrawal permits are co-located with MBSS-sampled streams (1st through 4th order).

Two preliminary analyses were conducted to begin answering this question: (1) MBSS data were examined to determine if "apparent" low flow conditions at MBSS sites have poor biological conditions (based on low IBI scores) that may be attributable to water withdrawals and (2) MDE

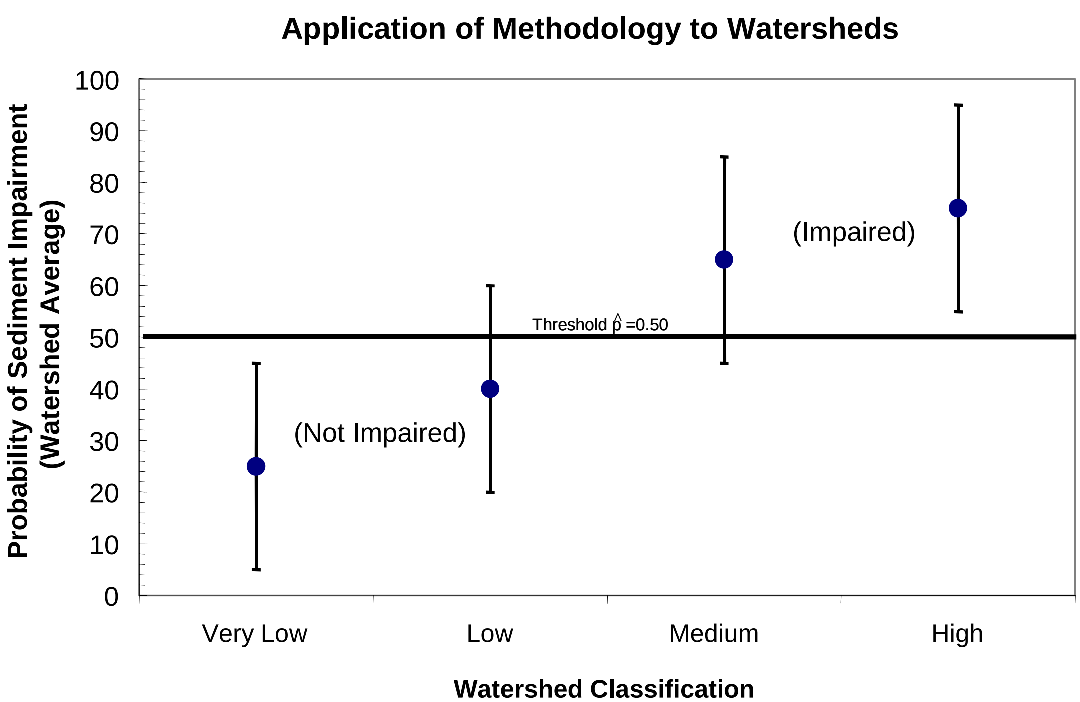

Figure 3-54. Recommended option for applying sediment indicator results to rating streams in watersheds for impairment of biotic assemblages due to sediment deposition

permit information in the Big Elk Creek watershed was used to seek associations between the relationship of seven permitted withdrawals and eight MBSS sites.

3.6.2.1 Analysis for Apparent Low Flow MBSS Sites

MBSS data from 1995 to 2002 were used to identify a subset of sites that had "apparent" low flows. Apparent low flows were defined as MBSS sites with low flow (or maximum depth, average width, or stream length sampled) compared to catchment size. Regression relationships were graphed for catchment size (watershed area draining to the MBSS site) as the independent variable and flow (one time measurement, usually baseflow) or other variable. This was done statewide and for each ecoregion (Highlands, Eastern Piedmont, and Coastal Plain). The R^2 for the statewide catchment-flow relationship was 0.35 (Highlands 0.17, E. Piedmont 0.51, Coastal Plain 0.48). The R^2 for catchment-maximum width was less than 0.20 for statewide and all regions. The R^2 for statewide catchment-average width was 0.52 (Highlands 0.52, E. Piedmont 0.59, Coastal Plain 0.51). The R^2 for statewide catchment-stream length sampled (a measure of proportion of stream segment that dried up) were all very low (less than 0.01) because most sites had no dry lengths (i.e., values were 75m). It should be noted that each of these dependent variables, even flow, includes considerable natural variability and are only incompletely representative of true flow. Nonetheless, "outliers" -- MBSS sites with lower flow surrogate values than predicted by the regression relationship -- were visible on each of the graphs.

Figure 3-55 illustrates the regression relationship for catchment area and flow statewide. The seven MBSS sites in the lower right corner appear to depart from the regression significantly. These and similar departures (apparent low flows) for the other variables were compiled into Table 3-5.

What is apparent from this analysis is that the apparent low flow MBSS sites do not have especially low biological conditions (only 1 of 9 fish IBI and 2 of 8 benthic macroinvertebrate IBIs were less than 3). Admittedly, this is a small sample of sites and they have not been evaluated for unusual natural conditions. Nonetheless, we can conclude that the "low flows," as identified here, do not appear to have altered habitat conditions enough to adversely impact the biota degraded conditions. If lower IBI scores had been noted, then further investigation into the situations (e.g., presence of other stressors) at each site would be warranted. That not being the case in this small data set, geographically specific water withdrawal data should be obtained so a more structured analysis can be conducted.

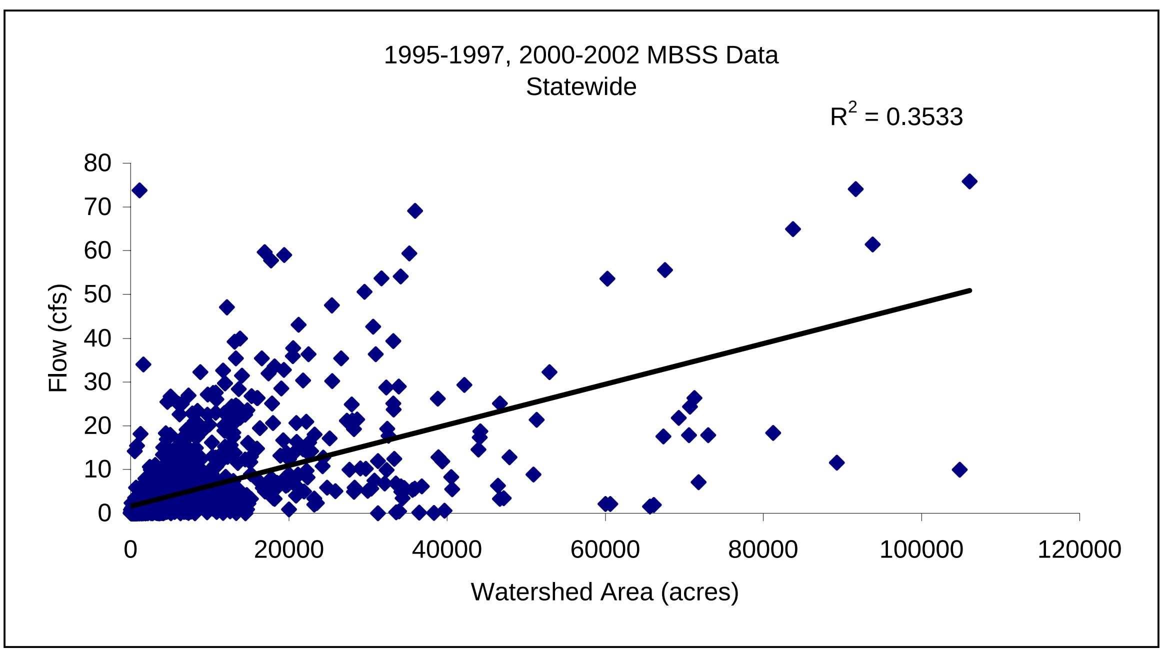

Figure 3-55. Relationship of flow and catchment (watershed) area at MBSS sites (1995-2002) showing outliers with "apparent low flows"

Table 3-5. MBSS Sites (1995-2002) with "Apparent Low Flows" (outliers in catchment area-flow surrogate regressions).									
Site	**Length Sampled**	**Maximum Depth**	**Average Width**	**Flow**	**Acreage**	**Strata**	**FIBI**	**BIBI**	**Reason**
DOUB-407-R-2002	75	24	21.38	1.53	65662.54	HIGHLAND	2.43	3.89	FLOW, DEPTH
JONE-312-R-2002	75	89	11.73	11.58	89312.32	EPIEDMNT	3.44	1.67	FLOW, WIDTH
SIDE-402-R-2001	57	47	17.85	1.91	66175.70	HIGHLAND	4.43	4.11	FLOW, DEPTH, SAMPLE LENGTH
SIDE-405-R-2001	75	123	10.63	2.16	60029.40	HIGHLAND	4.14	3.22	FLOW
SIDE-410-R-2001	75	93	12.05	2.16	60640.40	HIGHLAND	3.86	4.33	FLOW
TOWN-417-R-2002	75	50	13.63	9.98	104835.02	HIGHLAND	3.86	4.11	FLOW, DEPTH, WIDTH
WI-S-055-303-97	75	200	14.80	7.07	71830.65	COASTAL	3.00		FLOW
MATT-033-S-2001	65	94	6.80		40361.60	COASTAL	3.29	3.14	SAMPLE LENGTH
MATT-033-S-2002	56	81	4.18		40361.60	COASTAL	3.00	2.75	SAMPLE LENGTH

Acreage >= 55,000 and Flow < 12
Acreage > 60,000 and Depth < 60
Acreage > 80,000 and Width < 15
Acreage >=40,000 and Sample Length ^= 75

3.6.2.2 Relationship of Surface Water Withdrawals and Condition of Aquatic Resources in Big Elk Creek Watershed

After reviewing permitted surface water withdrawal data provided by the Water Rights Division of MDE, the Big Elk Creek watershed was selected for further investigation because it contained seven permitted withdrawals (Table 3-6) and eight MBSS sites (Table 3-8). Additional permit information was used to estimate locations of the withdrawals and display them in a GIS so that proximity to MBSS sites could be determined (Figure 3-56).

Four of the seven permitted withdrawals for the Big Elk Creek watershed contained minimum flow-by requirements. Flow-by requirements were waived for three permits for the following reasons:

- Stream is tidally influenced (map location #6)
- Withdrawal is from a pond (#1)
- "Existing water supply with overall inadequate supplies" (#5). In this case, the municipal water supply for Elkton is permitted to reduce the flow of Big Elk Creek below 11.9 cubic feet/second, or CFS (i.e., the minimum flow-by determined by MDE based on the 7Q10 Low Flow).

Three of the permits (#2, #3, and #4) allow withdrawals of "no more than 75% of the existing flow." In these cases, withdrawal is typically on an intermittent basis and usage appears to be small compared to stream flow.

Cumulative Withdrawals. State water appropriation permits limit surface water withdrawals to a daily average (on a yearly basis) and a maximum daily withdrawal in gallons. Average and maximum daily withdrawals for permits issued on Big Elk Creek were summarized to provide estimates for the range of cumulative permitted withdrawals (Table 3-7). These withdrawals could represent a reduction of 21% (avg.) and 40% (max.) during periods of low flow. For this example, stream flows of 11.9 CFS were considered "low flow." This value (11.9 CFS) is the waived minimum flow-by (based on the 7Q10LF method) for the town of Elkton. Although flows well below 11.9 CFS were documented in 1995 and 1999 (Figure 3-57), the permitted withdrawal amounts and their contribution to the low stream flows are not known. Conditions #13 and #14 of state water appropriation permits require permittees to measure all water used and submit pumping records to MDE on a semi-annual basis. These records may provide the information required to conduct a more detailed assessment in the future.

MBSS and Stream Flow Data. Sections of Big Elk Creek and its tributaries were sampled by the DNR's MBSS in 1996, 1997, and 2000. In the spring, biologists collect water samples and benthic macroinvertebrates for laboratory analysis. When revisited in the summer, biologists evaluated stream habitat, collected and identified stream fish, and took multiple width, depth, and water velocity measurements along a transect in order to calculate stream flow. Fortunately, a USGS stream gauging station is on Big Elk Creek at Elk Mills, near MBSS site CE-P-999-930. The record of stream flow for the period of 1994-2001 (Figure 3-57) was examined to provide a wider frame of reference for the timing of MBSS sampling visits.

An examination of this graph shows that on four occasions between 1994 and 2001, stream flow in Big Elk Creek at Elk Mills dipped below 15.3 CFS, the minimum flow-by for the mill race diversion that feeds DNR's fish rearing ponds in Elkton. On two occasions, stream flow

Table 3-6. Permitted surface water withdrawals and minimum flow-by requirements identified on Big Elk Creek.			
Permit Code	**Map Location**	**Owner's Name**	**Flow by Requirement**
CE1988S083 -2	1	FAIR HILL CONDOMINIUM ASSOC., INC.	None
CE1999S018 -2	2	FAIR HILL CONDOMINIUM ASSOC., INC.	<75%
CE1999S021 -1	3	CECIL COUNTY FAIR, INC.	<75%
CE1996S045 -1	4	BRISTOW, STEVE	<75%
CE1966S005 -8	5	TOWN OF ELKTON	11.9 CFS (Waived)
CE1999S003 -2	6	PGG, LLC	None
CE1986S054 -2	7	MARYLAND FISHERIES ADMIN.	15.3 CFS
* See Figure 3-55.			

Table 3-7. Average and maximum permitted withdrawals in the Big Elk Creek watershed		
Permittee	**Permitted Avg. Gallons/Day**	**Permitted Max Gallons/Day**
FAIR HILL CONDOMINIUM ASSOC. INC.	10,000	60,000
FAIR HILL CONDOMINIUM ASSOC. INC.	2,100	25,000
CECIL COUNTY FAIR INC	100	3,000
BRISTOW, STEVE,	10,000	72,000
TOWN OF ELKTON	1,500,000	2,000,000
PGG, LLC,	105,000	413,000
MARYLAND FISHERIES ADMINISTRATION	6,600	480,000
Total (GPD)	1,633,800	3,053,000

Table 3-8. Summary of data for MBSS sites sampled in the Big Elk Creek watershed.						
MBSS Site	**Site Number***	**Year**	**Stream Order Flow (CFS)****	**Stream**	**Fish IBI**	**Benthic IBI**
BELK-301-X	1	2000	3	26.2	3.9 (Fair)	3.0 (Fair)
CE-P-009-933	2	1997	3	27.7	4.5 (Good)	3.4 (Fair)
CE-P-999-930	3	1997	3	28.5	4.5 (Good)	2.6 (Poor)
CE-N-033-301	4	1996	3	68.7	4.8 (Good)	3.9 (Fair)
CE-P-009-305	5	1996	3	42.6	4.3 (Good)	3.8 (Fair)
CE-P-009-303	6	1996	3	50.6	4.1 (Good)	2.6 (Poor)
CE-P-085-931	7	1997	1 (dnstrm)	1.63	4.3 (Good)	3.0 (Fair)
CE-P-085-109	8	1996	1 (upstrm)	0.26	Not Rated	3.4 (Fair)
* Figure 3-56 ** Calculated by the MBSS						

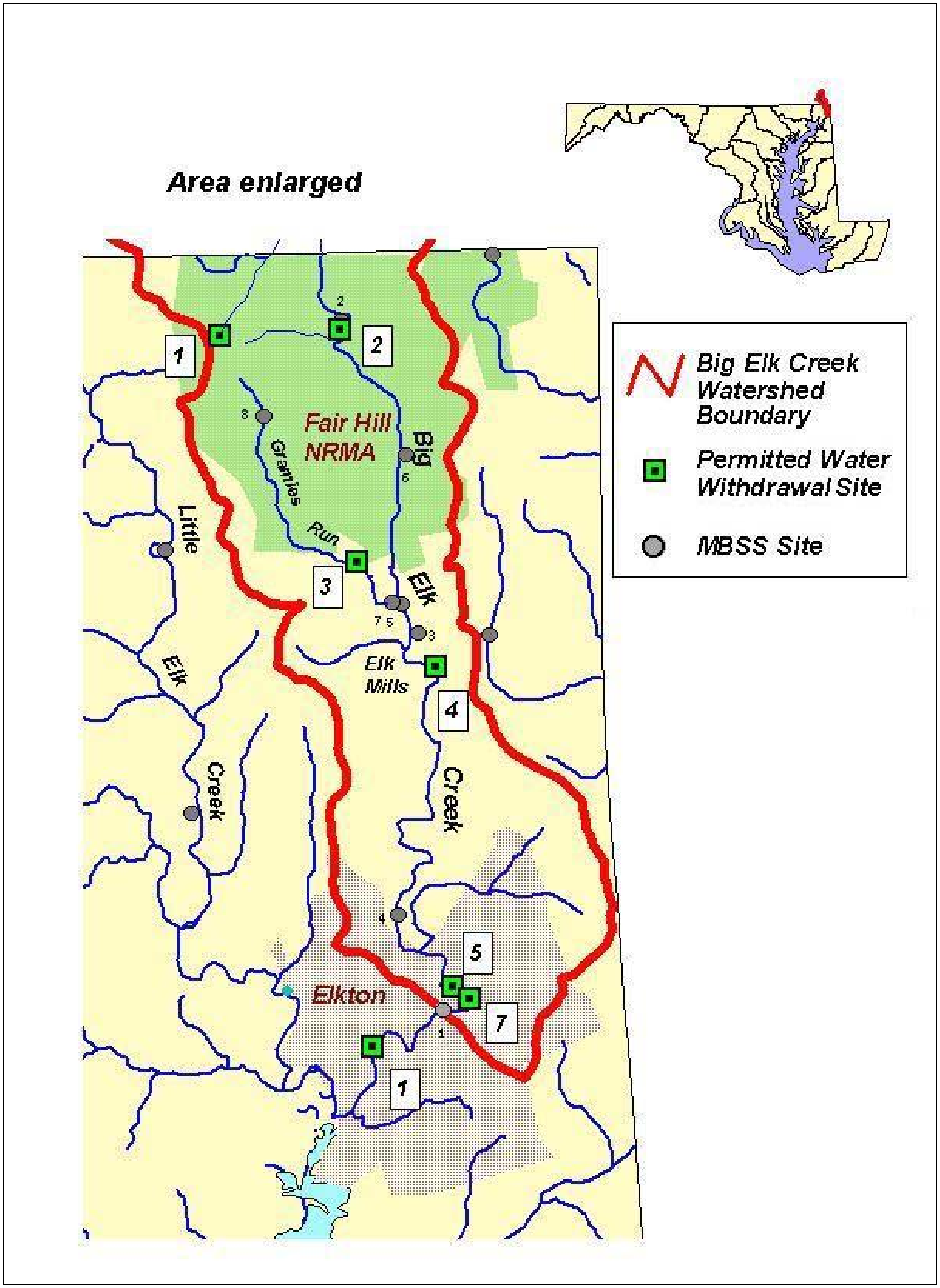

Figure 3-56. Big Elk Creek watershed in Maryland

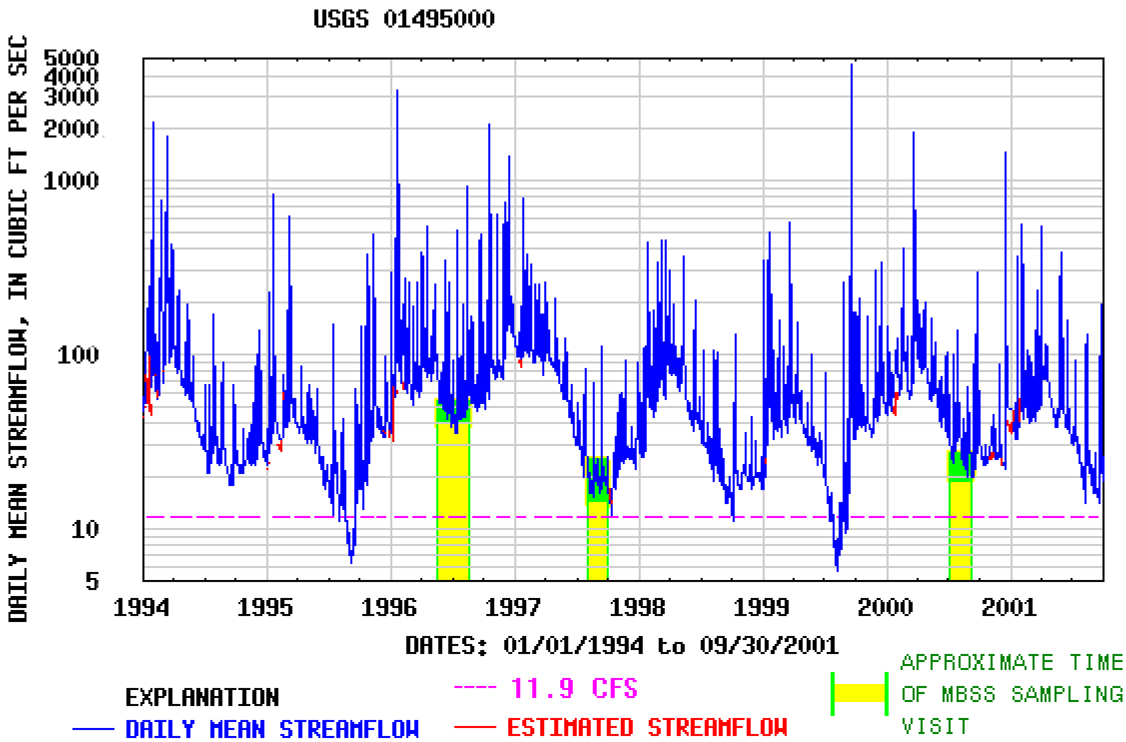

Figure 3-57. Daily mean stream flow for Big Elk Creek at Elk Mills, Maryland.

dipped below 11.9 CFS; the (waived) minimum flow-by requirement for the town of Elkton. These two low flow periods lasted for about 20 days in late summer 1995, and about 10 days in late summer 1999.

Fish IBI scores at all but one of the eight sites sampled in the Big Elk Creek watershed by the MBSS were classified as "Good" relative to reference conditions (Table 3-8). Site BELK-301-X, located in the center of Elkton, had a fish IBI score near the high end of the "Fair" range. Big Elk Creek is one of the larger streams sampled by the MBSS. Fish communities at these sites were relatively diverse, with over 20 species typically collected. Two gamefish species, rainbow trout and smallmouth bass, were collected at several sites.

IBI scores for benthic invertebrates at the sites on Big Elk Creek were typically classified as "Fair," with two sites scoring "Poor." Several of the benthic invertebrate samples were numerically dominated by the midges (Family Chironomidae), Orthocladius sp. and Cricotopus sp. These invertebrates are considered to be indicators of organic pollution. Benthic macroinvertebrate samples generally contained low diversity and numbers of invertebrates that are considered "sensitive to pollution" (e.g., mayflies, stoneflies, and caddisflies). Poor scores for benthic IBIs are most likely reflective of water quality issues related to runoff from nearby roads and the relatively high (61%) amount of agriculture in the watershed.

Evaluations of the instream physical habitat for MBSS sites in the Big Elk Creek watershed for several parameters generally scored "Good." Parameters such as instream habitat (for fish), epifaunal substrate (for benthic invertebrates), pool and riffle quality, and velocity/depth diversity were rated "optimal" and "sub-optimal." Some sections of Big Elk Creek suffer from moderate bank erosion and higher riffle embeddedness (sediment deposition).

<u>Conclusion</u>. An examination of DNR's MBSS data collected in the Big Elk Creek watershed between 1996 and 2000 does not suggest that permitted surface water withdrawals operating during this time were a major stressor on the fish or benthic macroinvertebrate communities at these sites. Two items related to the MBSS sampling design make it difficult to identify linkages

between this subset of water withdrawal amounts and biological community data:

- MBSS sites were randomly chosen and not intentionally located near permitted water withdrawals.
- The MBSS did not sample Big Elk Creek in 1995 or 1999, two of the more recent drought periods when surface water withdrawals would be most likely to cause adverse ecological effects.

The list of permitted surface water withdrawals submitted to DNR by MDE contains 921 active permits. The format and structure of this list does not facilitate an assessment of flow-by requirements for water withdrawal permits. Three aspects of the information provided limit DNR's ability to analyze it adequately:

- Lack of access to the MDE database used to generate the permit listing prevents DNR from efficiently querying the data to identify areas of the state with data from both programs.
- It is not known which water withdrawal permits require a minimum flow-by, nor the value of the flow-by requirement. It would also be helpful to know which method was used to determine the flow-by values. There appear to be three categories: 7Q10LF, the "Maryland most common flow" method, and withdrawal of no more than 75% of the existing flow.
- The list of permits contains generalized 'North' and 'East' grid coordinates but does not contain coordiates easily incorporated into a Geographic Information System (GIS).

3.6.2.3 Future Analysis on Low Flow

As stated above, the critical need is for digital location information on current surface water withdrawals across the state that can be overlaid on the MBSS stream network (1:100,000 scale) within a GIS. Once this information has been obtained, DNR will be able to determine which withdrawals occur near MBSS sites (i.e., where the MBSS site occurs between the withdrawal and the next downstream confluence and especially where the withdrawal occurs between two MBSS sites), what is the character of these withdrawals, and whether these withdrawals are coincident with low flows and adverse biological effects. DNR would like MDE to provide a dataset (in dBase, Excel, or other common format) of the 921 permitted surface water withdrawals that includes the following information:

- Name of withdrawal site (common identifier for each permit)
- Geographic location (e.g., latitude and longitude or northings and eastings in GIS format)
- Minimum flow-by requirements (for all sites where they pertain)
- Monitoring results or water usage (pumping) records by date and site

3.6.3 Stream Corridor Assessments

The MBSS provides excellent coverage of the State at the scale of the Maryland 8-digit watersheds (approximately 50 mi^2). The mean IBIs for fish and benthic macroinvertebrate assemblages (and proportion of stream miles in each IBI class) provide robust measures of the cumulative stress on biological communities at this scale. In addition, stressor and stressor-surrogate variables sampled at MBSS sites provide areawide estimates of the extent and severity of water quality and physical habitat conditions. MBSS data do not, however, provide coverage of stressor presence at the next larger stream reach scale. For example, when evaluating the stressors potentially affecting biological condition at an individual MBSS site, the presence of an adequate riparian buffer along the 75-m sample segment could be misleading if the riparian buffer has been removed along the entire reach upstream of the site. Stressor identification in Maryland streams would be greatly enhanced if data on the reach level could be combined with MBSS data collected at the segment level. Fortunately, Maryland DNR is conducting reach-level Stream Corridor Assessments (SCA) as part of the State's Watershed Restoration Action Strategies (WRAS) in selected 8-digit watersheds (Yetman 2001). The analysis in this section describes a preliminary evaluation of the utility of combining MBSS and SCA data for stressor identification.

<u>Study Approach</u>. The ultimate goals of combining MBSS and SCA data are the following: (1) determine if data collected by SCA can explain the variance in IBI that remains after MBSS variables are accounted for (i.e., the residual IBI) and (2) determine if certain MBSS IBI signatures can be explained with SCA data (i.e., so that biological metrics are diagnostic of stressors). This analysis begins to address these goals by asking specific questions. It has answered these questions to the extent possible given the SCA data sets that currently exist. Recommendations for using additional SCA data as it becomes available and for targeting MBSS sampling within SCA watersheds are presented at the end of the section.

<u>Background</u>. MBSS data are comprehensive at the scale of 8-digit watersheds, with 10 to 21 sites per watershed

(or watersheds combined into Primary Sampling Units or PSUs). SCA data are intensive, covering the entire stream network of selected 8-digit watersheds through "stream walks," which inventory each individual problem site along a stream, and "representative sites," which document the instream and riparian habitat conditions along small stretches of a stream (approximately 300 feet in length). These habitat assessments are based on an array of habitat metrics similar to those used in the MBSS summer habitat assessment. MBSS data are available statewide for these preliminary analyses the period 1995 to 2003. At the time of these analyses, available SCA data included that for the Ballenger Creek, Breton Bay, Georges Creek, and Upper Patuxent River (Anne Arundel portion) watersheds. Future analysis may be conducted on the Liberty Reservoir watershed data and that of other watersheds as they become available.

The SCA data collected for the Breton Bay and Upper Patuxent River watersheds are not ideal for comparison with MBSS data because few MBSS sites were sampled in these watersheds (Table 3-9). In Breton Bay, much of the stream network is tidal, and therefore, the MBSS sampling area was limited within the watershed. In addition, three of the four MBSS sites in the watershed have no FIBI or PHI scores because the sites were dry during the summer index period. A limited portion of the Upper Patuxent River watershed (50 stream miles) was surveyed during the SCA and only one MBSS sites falls within that portion of the watershed. Data comparisons are also limited by the need for MBSS sites and representative SCA sites to be in close proximity (Figure 3-58). More specifically, MBSS sites must be located very near or just downstream from the SCA reaches to be useful for these analyses. Further analysis of these watersheds could be done if targeted MBSS sampling was conducted near SCA representative sites.

Questions: *Within watersheds, are the assessments of habitat quality by the MBSS and SCA comparable? What is the relative precision of these assessments?*

The SCA assesses stream habitat quality with ten variables (scored visually from poor to optimal); the average of these variable values was used at each site to describe overall habitat quality. The MBSS uses the reference-based physical habitat index (PHI) to describe stream habitat quality. Several of the individual metrics used are directly comparable, for example the SCA metric for attachment sites for macroinvertebrates is looking for the same substrate characteristics as the MBSS metric for epifaunal substrate. Other metrics relate to one another less directly but are still connected, such as the SCA metric for sediment deposition and the MBSS metric for pool quality. An overall score can be obtained from each assessment, and the metrics contributing to that overall score are similar, so it is reasonable to compare the habitat assessment results from both survey methods.

Despite some differences found during the comparison of individual cases in Georges Creek, there is a high degree of relative precision between the habitat assessments of these two surveys. Scores generated by both surveys agreed on the condition of both individual sites and overall watersheds. The average of the SCA representative site habitat scores and the average of the PHI scores both put the overall habitat quality for each of the watersheds in the same narrative category. In Ballenger Creek, where SCA and MBSS sites overlapped or nearly overlapped, there was agreement in 4 out of 5 cases. Overlapping sites in Georges Creek did not show the same degree of concordance; only 1 site was in the same quality category, though the other 6 sites differed by only by one category (Figure 3-59). This may be result of temporal differences, since data for the two surveys were collected over an extended period of time, i.e., from 1996 to 2002.

Questions: *Within watersheds, do individual physical habitat variables that purport to measure the same thing give comparable results? What is their relative precision?*

The differences in the two stream surveys make it difficult to compare certain individual habitat metrics. For example, the MBSS estimates the average buffer width, while the SCA measures both the length of buffer and the width of any inadequate buffers. Comparing the two measures is further complicated by the fact that the SCA assesses the buffer within 50 feet of the streambanks, whereas the MBSS assesses the buffer within 50 meters of the streambanks.

Of those metrics that are measured in a similar manner, we choice to examine erosion in further detail. The MBSS measures the eroded area along each 75-meter stream to estimate total bank erosion within a watershed. The SCA provides an approximate measurement of bank erosion throughout the entire watershed, based on walking the entire stream length. Estimates for eroded bank area (MBSS) were approximately 15% less than those estimated by the stream walks (SCA), a fairly close match. This comparison was complicated by the fact that the total number of stream miles in each watershed (according to the MBSS stream network) were not necessarily the same number of stream miles actually walked by the SCA crews, but this difference was accounted for whenever possible.

Table 3-9. Summary of the type and number of sites within the various watersheds sampled using both MBSS and SCA methods. Overlapping sites are those where MBSS and SCA sites are located in close enough proximity to one another that the habitat assessments would be expected to yield similar results.

WATERSHED	No. of MBSS Sites	No. of SCA Representative Sites	No. of Overlapping Sites	Miles of Stream Inventoried by SCA
Ballenger Creek	6	27	5	33
Breton Bay	4*	116	4	77
Georges Creek	17	175	7	108
Liberty Reservoir (Carroll County portion)	21**	91	11	95
Upper Patuxent (Anne Arundel portion)	1**	30	1	50

* During the MBSS summer index period, three of these sites were dry; they lack FIBI and PHI scores.

** This number is not representative of the total number of MBSS sites within the watershed. This is the number of MBSS sites within the portions of the watershed that were surveyed during the SCA.

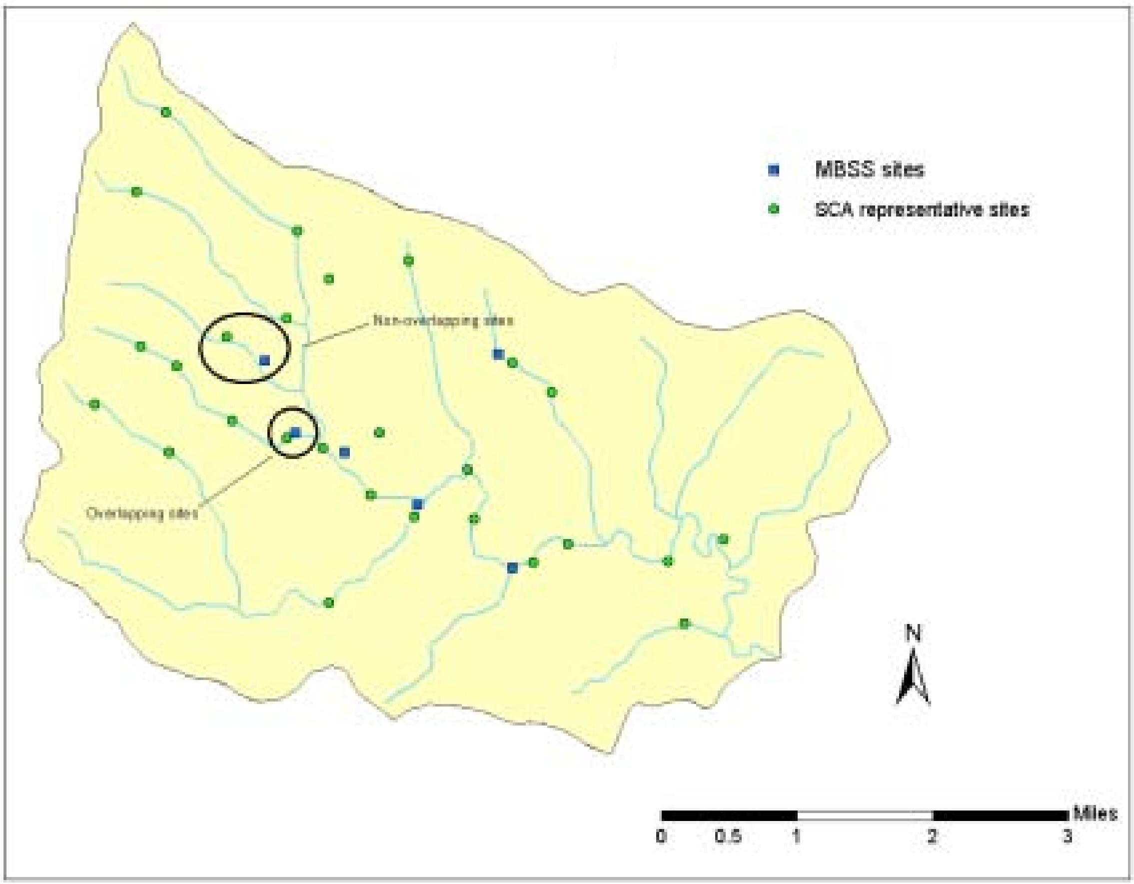

Figure 3-58. Overlap between MBSS and SCA sites in the Ballenger Creek watershed

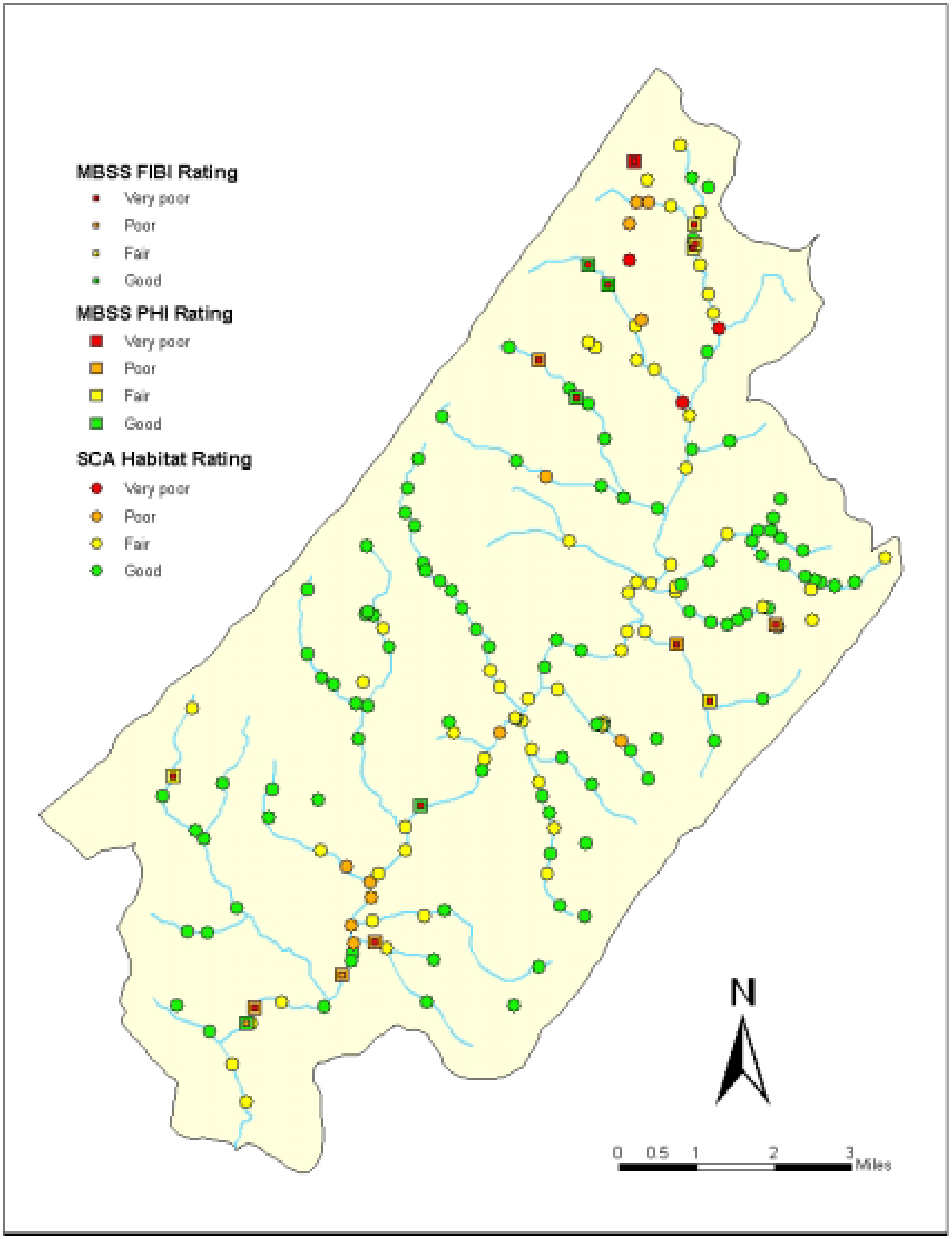

Figure 3-59. Map of SCA habitat conditions upstream of MBSS sites in the Georges Creek watershed.

Question: *For those MBSS sites where IBIs are lower than predicted from the site-specific PHI (i.e., where local stream habitat quality does not appear to be limiting), do SCA physical habitat scores for the full upstream reach explain the difference?*

Both Ballenger Creek and Georges Creek watersheds showed a strong relationship between PHI scores and SCA inadequate buffer sites upstream; both the number and severity of which seemed to play a role. Inadequate buffers sites in Ballenger Creek were almost all of a higher severity, while Georges Creek sites showed a range of severities. In both cases, the relationship between inadequate buffers and the PHI was a strong one. It is difficult at this point, however, to say if the habitat conditions upstream of an MBSS site, as assessed by the SCA, can explain lower IBI scores than those predicted by the PHI. In several instances, MBSS sites fell near the headwaters of the stream, so there were no SCA representative sites and few SCA inventory problems found upstream. In cases where there were upstream SCA habitat scores for the few sites that had data from both surveys did not consistently predict MBSS IBI scores. As more watersheds are assessed by SCA, a clearer connection between upstream SCA habitat scores and IBIs may become apparent, or the results may point to particular stressor problems (identified by SCA inventory) that explain the differences at specific sites. Targeting future MBSS sites in areas of good local habitat, but poor habitat upstream, (i.e., in a special study designed to more rigorously address this question) may be a more productive approach.

Question: *Can data collected by the SCA explain the variance in IBIs that remains after MBSS variables are accounted for (i.e., residual variation).*

In attempting to answer the three previous questions, we have shown that physical habitat condition at the site and upstream only partially explain IBI scores. Therefore, it is useful to look at the broad array of stressors and other factors that the SCA assesses. For example, some MBSS sites in Georges Creek with lower IBI scores than would have been expected (i.e., based on higher PHI scores) showed a potential relationship with nearby acid mine drainage (AMD) sites noted during the SCA; others did not have AMD sites nearby. Water chemistry data from the MBSS showed that sites located downstream of the SCA AMD sites showed signs of acidification, including elevated conductivity and sulfates and relatively low acid neutralizing capacity (ANC).

Question: *For those MBSS sites where IBIs are lower than predicted PHIs, do the synoptic pollutant variables sampled for the WRASs (e.g., nutrients) explain the differences between comparable reaches?*

We contacted Niles Primrose (DNR Watershed Services) to obtain synoptic sampling results for the following watersheds:

- Ballenger Creek, Frederick County
- Breton Bay, St. Mary's County
- Georges Creek, Allegheny and Garrett County
- Liberty Reservoir, Carroll County
- Upper Patuxent River, Anne Arundel County

Planned analyses include comparing the results of the synoptic water chemistry with those of water chemistry taken at nearby MBSS sites, and looking into what role upstream water chemistry may play at sites where the PHI suggested a higher IBI score than was found.

<u>Future Analyses with SCA and MBSS Data</u>. To date, a combined analysis of MBSS and SCA data is limited by the small number of watersheds with SCA results and the fact that not all MBSS sample sites and SCA reaches are in close enough proximity for valid comparisons. As SCAs are conducted in more watersheds, the amount of data available for these comparative analyses will increase. Even so, it may be more effective to conduct targeted MBSS sampling coincident with SCAs (i.e., downstream of SCA reaches that cover the full range of the human disturbance gradient), so that specific questions can be answered with an experimental design. Additional analyses with SCA and MBSS will be completed in 2005.

4 SUMMARY OF SAMPLING RESULTS FOR INDIVIDUAL WATERSHEDS

Since the primary focus of the 2000-2004 Round Two of the MBSS (or Survey) is on smaller watersheds than in Round One, more attention has been paid to examining sampling results and potential stressors at individual sites. Although a complete assessment of watershed-wide conditions would require more information, data collected at specific MBSS sites provide a starting point for understanding and describing the condition of the watershed.

This chapter includes a summary for each of the 19 primary sampling units or PSUs (single or combined 8-digit watersheds) randomly sampled in the 2003 MBSS. Each summary begins with a map of the PSU, which shows 8-digit watershed and 12-digit subwatershed boundaries, county boundaries, major towns and roads, and selected public lands. This information provides a geographical context for the sites sampled by the Survey. These maps also include the locations of the MBSS sample points and MBSS Stream Waders sample locations (see sidebar in this chapter for further information regarding the MBSS Stream Waders program), with symbols indicating the fish and benthic macroinvertebrate IBI scores (a key to this map is included in Table 4-1).

Each PSU summary includes a land cover map derived from the Multi-Resolution Land Characteristics (MRLC) Version 98-07 (based on remote sensing data from the early 1990s). A key to this map is provided in Table 4-1. A bar chart for each 8-digit watershed shows the percentage of land in each land cover class.

Following the maps are tables containing a variety of information on the sites sampled in each PSU. The first table contains locational information for each site, including the stream name, 12-digit subwatershed code, 8-digit watershed name, basin, county, stream order, and upstream catchment area. The second table is one containing information pertinent to the indicators calculated for each site (fish, benthic, and physical habitat). The third table gives the percentage of the upstream catchment area in urban, agricultural, forested, or other (water, barren, and/or wetlands) land cover for each site. Below these tables is a short summary of the conditions in the PSU, including pertinent comments taken from field data sheets. A water chemistry table is provided, including values for the analytes measured at each site (see Chapter 2). Two tables providing information on physical habitat quality and modifications are also included in each PSU report. Throughout these tables, values that exceed or fall short of established thresholds (denoting likely degraded condition or potential stress) are shaded in yellow. The final table is a list of Stream Waders sites in the PSU, along with the family level benthic macroinvertebrate IBI score calculated for each site. A key to the variables in all of these tables is given in Table 4-1.

Finally, each PSU report includes a list of organisms collected in the PSU during 2003 MBSS sampling. Included on this page are species lists for fish, exotic plants, and herpetofauna, as well as a taxa list for benthic macroinvertebrates. Taken together, these data can be used to begin to assess stream quality in each PSU. For example, in the Potomac River Upper Tidal/Oxon Creek PSU, indicator scores at most sites are generally low, indicating that most streams sampled in the PSU are disturbed. Maps and data also indicate that urban and suburban land uses are widespread and that many sampled sites had elevated chloride, nitrogen (especially ammonia), and phosphorus levels, as well as channelization and erosion problems. In this PSU, development is probably a significant stressor on stream water quality, contributing to elevated pollution and physical habitat degradation, which in turn result in low indicator scores. A similar assessment can be done for each PSU, providing a preliminary identification of the specific stressors of concern in the PSU.

Table 4-1. Key to PSU reports for PSUs sampled in the 2003 MBSS

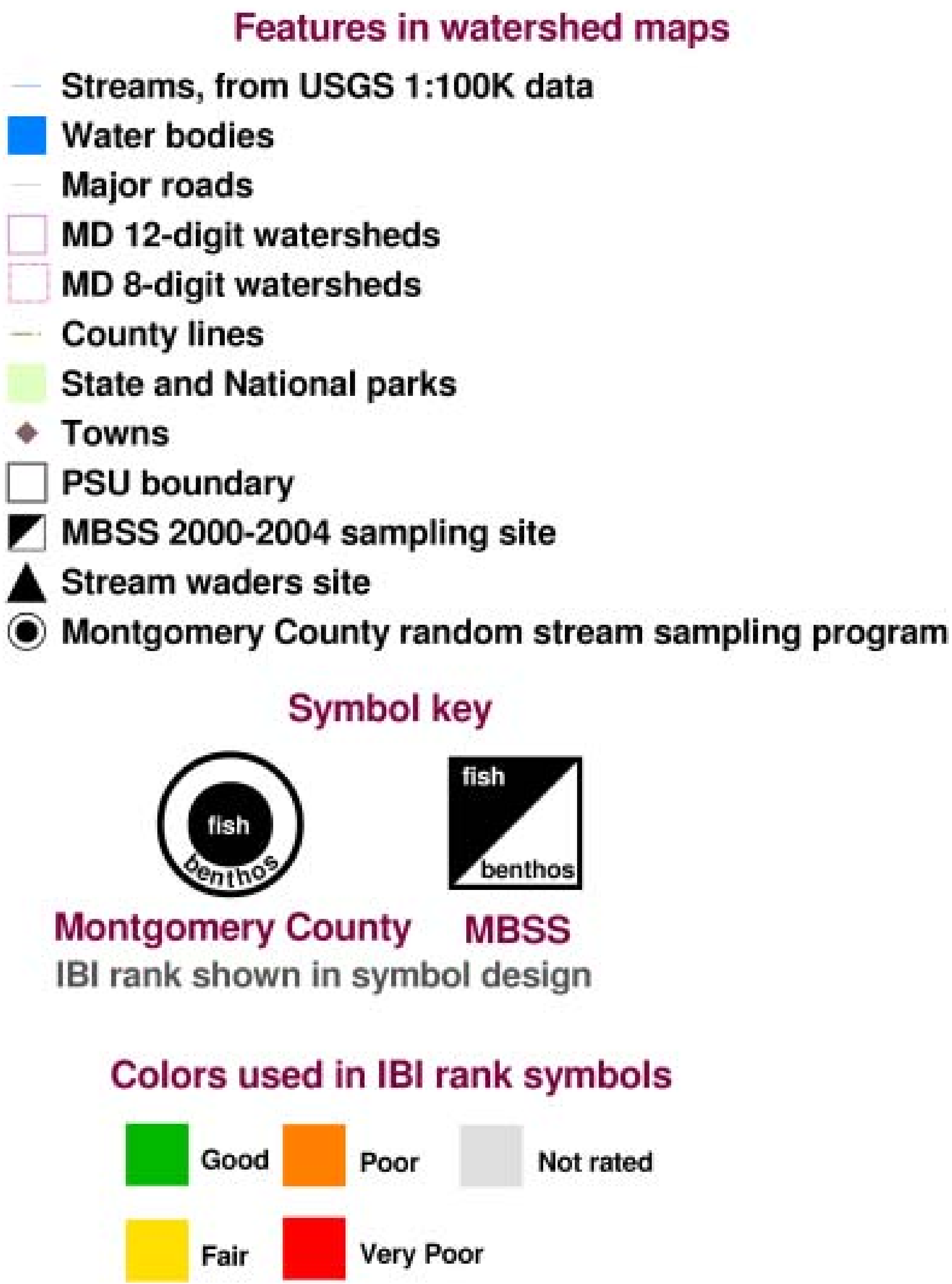

Table 4-1. (Continued)

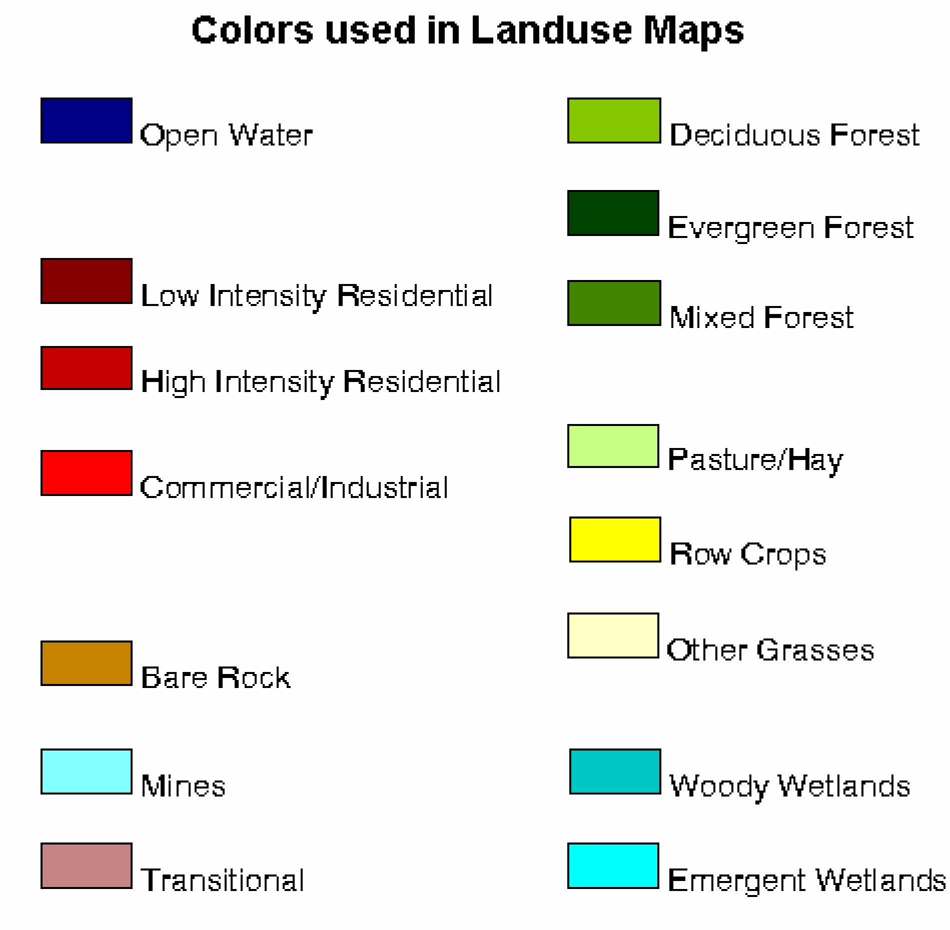

Table 4-1. (Continued)

Guide to Variables in PSU Reports

<u>Site Information</u>

Site: MBSS site name, in the following format: Watershed Abbreviation - Segment Number - Site Type - Year Sampled
(Site Type R = Randomly selected site)

Stream Name: Name of stream sampled

12-digit Subwatershed Code: Maryland 12-digit watershed code

8-digit Watershed: Maryland 8-digit watershed name

Basin: Maryland drainage basin name

County: Maryland county

Date Sampled Spring: Date site was sampled in the spring

Date Sampled Summer: Date site was sampled in the summer (NS = Not Sampled)

Order: Strahler stream order

Catchment Area: Area of upstream catchment in acres

<u>Indicator Information</u>

FIBI: Fish Index of Biotic Integrity, scored on the following scale:
- 1.0 - 1.9 Very Poor
- 2.0 - 2.9 Poor
- 3.0 - 3.9 Fair
- 4.0 - 5.0 Good
- NS Not Sampled
- NR Not Rated (site is not rated if catchment area is < 300 acres, or if the site is a brook trout or blackwater stream and would have received a score of less than 3.0)
- Site is shaded if IBI score is < 3.0

BIBI: Benthic Index of Biotic Integrity, scored on the following scale:
- 1.0 - 1.9 Very Poor
- 2.0 - 2.9 Poor
- 3.0 - 3.9 Fair
- 4.0 - 5.0 Good
- NS Not Sampled
- NR Not Rated
- Site is shaded if IBI score is < 3.0

Table 4-1. (Continued)

PHI: Physical Habitat Index, scored on the following scale:
- 0 - 11.9 Very Poor
- 12 - 41.9 Poor
- 42 - 71.9 Fair
- 72 - 100 Good
- NS Not Sampled
- NR Not Rated
- Site is shaded if PHI score is < 42

Brook Trout Present: 0 = Not present in sample segment, 1 = Present in sample segment, NS = Not Sampled

Black Water Stream: 0 = Not a blackwater stream, 1 = Blackwater stream (pH < 5 or ANC < 200 µeq/L and Dissolved Organic Carbon ≥ 8 mg/L),
NS = Not Sampled

Catchment Land Use Information

Percent Urban: Percentage of urban land use in catchment upstream of site. Site is shaded if value is $\geq$ 25%.

Percent Agriculture: Percentage of agricultural land use in catchment upstream of site. Site is shaded if values is $\geq$ 75%.

Percent Forest: Percentage of forested land use in catchment upstream of site

Percent Other: Percentage of other land use in catchment upstream of site (other = wetlands, barren, and water)

Percent Impervious Surface: Percentage of impervious surface in catchment upstream of site. Site is shaded if value is $\geq$ 10%

Water Chemistry Information

Closed pH: Lab pH, sampled in the spring. Site is shaded if value is < 5.0.

Specific Cond.: Specific Conductivity (μmho/cm)

ANC: Acid Neutralizing Capacity (μeq/L). Site is shaded if value is < 200 ueq/L.

Cl: Chloride (mg/L). Site is shaded if value is $\geq$ 30 mg/L.

Nitrate-N: Nitrate Nitrogen (mg/L). Site is shaded if value is $\geq$ 1.0 mg/L

SO4: Sulfate (mg/L). Site is shaded if value is $\geq$ 50 mg/L.

T-P: Total Phosphorus (mg/L). Site is shaded if value is $\geq$ 0.0175 mg/L.

Ortho-P: Orthophosphate (mg/L). Site is shaded if value is $\geq$ 0.005 mg/L.

Nitrite: Nitrite Nitrogen (mg/L). Site is shaded if value is $\geq$ 0.0075 mg/L.

Ammonia: Ammonia (mg/L). Site is shaded if value is $\geq$ 0.025 mg/L.

T-N: Total Nitrogen (mg/L). Site is shaded if value is $\geq$ 2 mg/L

DOC: Dissolved Organic Carbon (mg/L). Site is shaded if value is $\geq$ 8.0 mg/L.

DO: Dissolved Oxygen (mg/L). Site is shaded if value is $\leq$ 5 mg/L.

Turbidity: Turbidity (NTUs). Site is shaded if value is $\geq$ 10 NTUs.

Table 4-1. (Continued)

Physical Habitat Condition

Riparian Buffer Width Left: Width of the riparian buffer on the left bank (meters). Site is shaded if value is < 10 m.

Riparian Buffer Width Right: Width of the riparian buffer on the right bank (meters). Site is shaded if value is < 10 m.

Adjacent Cover Left: Type of adjacent land cover on the left bank

Adjacent Cover Right: Type of adjacent land cover on the right bank

The following variables are scored on this scale:

0-5 Poor
6-10 Marginal
11-15 Sub-optimal
16-20 Optimal
Sites are shaded if scores are ≤ 6.

Instream Habitat Structure: Scored based on the value of instream habitat to the fish community

Epifaunal Substrate: Scored based on the amount and variety of hard, stable substrates used by benthic macroinvertebrates (or benthos)

Velocity/Depth Diversity: Scored based on the variety of velocity/depth regimes present at a site

Pool/Glide/Eddy Quality: Scored based on the variety and complexity of slow or still water habitat present at a site

Riffle Run Quality: Scored based on the depth, complexity, and functionality of riffle/run habitat present at a site

Extent of Pools: The extent of pools, glides, and eddys present at a site (meters). Site is shaded if value is 0 m.

Extent of Riffles: The extent of riffles and runs present at a site (meters). Site is shaded if value is 0 m.

Embeddedness: Scored as a percentage (0-100) based on the fraction of surface area of larger particles surrounded by finer sediments. Site is shaded if value is 100%.

Shading: Scored as a percentage (0-100) based on estimates of the degree and duration of shading of sites during the summer. Site is shaded if value is 0%.

Trash Rating: Scored base on the visual appeal of the site and the presence/absence of human refuse. Site is shaded if value is ≤ 6.

Maximum Depth: Maximum depth of the stream (centimeters). Site is shaded if value is ≤ 20 cm.

Physical Habitat Modifications

Buffer Breaks?: Presence/absence of breaks in the riparian buffer, either right or left bank (Y/N). Site is shaded if value is Y.

Surface Mine?: Surface Mine present at the site (Y/N). Site is shaded if value is Y.

Landfill?: Landfill present at the site (Y/N). Site is shaded if value is Y.

Channelization: Stream channelization evident at the site (Y/N). Site is shaded if value is Y.

Erosion Severity Left - Severity of erosion on left bank (Severe, Moderate, Mild, or None). Site is shaded if value is Severe.

Erosion Severity Right - Severity of erosion on right bank. Site is shaded if value is Severe.

Bar Formation - Extent of bar formation in stream (Severe, Moderate, Mild, or None). Site is shaded if value is Severe

Table 4-1. (Continued)

Watershed Abbreviations

ANTI	Antietam Creek
BELK	Big Elk River
BOHE	Bohemia River
BROA	Broad Creek
CABJ	Cabin John Creek
CATO	Catoctin Creek
CHRI	Christina River
GEOR	Georges Creek
LIBE	Liberty Reservoir
LICK	Little Chester River
LIEL	Little Elk Creek
LIGU	Little Gunpowder Falls
LMON	Lower Monocacy River
LOCK	Lower Chester River
MAGO	Magothy River
MANO	Manokin River
MICR	Middle Chester River
MILE	Miles River
PCSO	Pocomoke Sound
PRLN	Potomac River Lower North Branch
PTOB	Port Tobacco River
ROCK	Rock Creek
SEVE	Severn River
STMA	St. Mary's River
TUCK	Tuckahoe Creek
UELK	Upper Elk River
WCHE	West Chesapeake Bay
WYER	Wye River

Land Cover Type Abbreviations

CP	Cropland
DI	Dirt Road
EM	Emergent Vegetation
FR	Forest
GR	Gravel Road
HO	Housing
LN	Mowed Lawn
LO	Logged Area
OF	Old Field
OR	Orchard
PA	Pasture
PK	Parking Lot/Industrial/Commercial
PV	Paved Road
RR	Railroad
SL	Bare Soil
TG	Tall Grass

MBSS Stream Waders - Volunteer Benthic Sampling Program

Introduction

Begun in 2000 as a component of the MBSS, Maryland Stream Waders is a statewide volunteer stream-monitoring program managed by DNR. Goals of Stream Waders are to:

- increase the density of sampling sites for use in stream and watershed assessments;
- improve stream stewardship ethics and encourage local action to improve watershed management;
- educate the local community about the relationship between land use and stream quality; and
- provide quality assured information on stream quality to state, local, and federal agencies, environmental organizations, and others.

Stream Waders data are intended for use in water quality reports (such as Maryland's biennial water quality report to Congress – the 305(b) Report), watershed restoration and protection programs, regulatory programs (such as 303(d) listing), and for local government use. They are also provided to the volunteers themselves who may have an interest in a particular stream or watershed.

Methods

Stream Waders is designed to be seamless with the MBSS and monitoring programs conducted by several other organizations, such as Montgomery County, who are sampling stream benthos in Maryland. MBSS samples are collected at the watershed level (8-digit), while Stream Waders volunteers sample at the subwatershed (12-digit) level. Thus, Stream Waders data should help "fill the gaps" left in watershed areas not sampled by MBSS.

Each year, local governments and citizen organizations interested in the selected watersheds (the same watersheds chosen to be sampled that year by the core MBSS) were invited to submit site locations to be sampled by Stream Waders volunteers. For 2003, about 80 sites were chosen by local government agencies and citizen organizations. These preselected sites, along with others chosen to support DNR-supported programs (e.g., Watershed Restoration Action Strategies) were prioritized over others. For subwatersheds with few or no pre-selected sites, volunteers were asked to distribute additional sites throughout the subwatershed, with one site near the most downstream portion of the catchment. Most sites were either upstream of a road crossing or within an easy walk of a road. Volunteers selected 100-foot sections of stream for their samples. Each team of volunteers was given a GPS unit to record the latitude and longitude of the actual sampling sites.

A total of 214 volunteers were trained at four eight-hour training sessions in February 2003. For 2003, 33 watersheds were slated for sampling. Each of the 51 volunteer teams that formed during the training sessions were asked to select four subwatersheds and to sample five sites within each subwatershed. Volunteers sampled during the 1 March to 30 April spring index period.

Benthic macroinvertebrates were sampled using the same methods as MBSS biologists (Boward 2001 and Kazyak 2001). Samples were preserved in ethanol and organisms were subsampled (about 100 organisms per sample) and identified to family (Boward and Friedman 2000) by DNR staff at DNR's laboratory in Annapolis. From the list of organisms identified from each site, a family-level Index of Biotic Integrity (IBI) was calculated and each site was rated either Good (IBI 4-5) Fair (IBI 3-3.9) or Poor (IBI 1-2.9) (Stribling et al. 1998).

In addition to sampling benthos at each site, volunteers noted general information about each stream, such as width and depth, as well as a description of the surrounding land and potential problems.

Results

In all, 358 sites in 85 twelve-digit watersheds were sampled during the 2003 Maryland Stream Waders Program. IBI results for these sites are included in the appropriate PSU summary located in this Chapter. A summary of Stream Waders results by MBSS PSU is included in the following table.

Summary of 2002 Stream Waders IBI Results

Primary Sampling Unit (PSUs)	Number of Stream Waders Sites	Summary
Antietam Creek	19	All sites were in the Beaver Creek drainage. About one half of them were rated Very Poor; one fourth were rated Poor and one fourth were rated Fair. The two MBSS sites in the Beaver Creek drainage were rated Fair or Poor.
Broad Creek	0	NA
Catoctin Creek	40	About two thirds of all sites were rated either Very Poor or Poor. Three sites were rated Good (one had a perfect score of five). Results generally agree with those of MBSS, with most higher scoring sites in the upper portions of the watershed north of Middletown.
Georges Creek	9	Two thirds of all sites were rated either Very Poor or Poor. One site near Savage River State Forest, was rated Good. Results generally agree with those of MBSS.
Honga River/Little Choptank River/Lower Choptank River	15	About two thirds of all sites were rated Poor or Very Poor. The remainder were rated Fair. Results generally agree with those of MBSS.
Liberty Reservoir	69	About two thirds of all sites were rated Poor or Very Poor, with six sites rated Good. As with MBSS sites, more Poor sites were in the upper reaches of the watershed outside reservoir protected areas.
Little Gunpowder Falls	15	Three fourths of all sites were rated Fair and one fourth were rated Poor. There were no Good or Very Poor sites. These results compare quite well with those of MBSS.
Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River	11	All sites were in the Big Elk Creek drainage. Two thirds of all sites were rated Very Poor or Poor. All other sites were rated Fair. In Fair Hill NRMA, one MBSS site was rated Good and two Stream Waders sites were rated Fair. Otherwise, MBSS and Stream Waders results were comparable in this watershed.
Lower Monocacy River	22	Most sites were rated Poor or Very Poor. Only one site was rated Good (in the Little Bennett Creek drainage). MBSS and Stream Waders results were comparable in this watershed.
Magothy River/Severn River	46	About three fourths of all sites were rated Poor or Very Poor. Four sites, in the Severn River drainage, were rated Good. Most higher-rated sites were in or near the Severn Run Natural Environment Area.
Middle Chester River	10	All sites were rated Poor or Very Poor and results generally agree with those of the MBSS.
Miles River/Wye River	16	Three fourths of all sites were rated Poor or Very Poor. Only one site, on Skipton Creek, was rated Good.
Pocomoke Sound/Tangier Sound/Big Annamessex River/Manokin River	0	NA
Port Tobacco River	38	About one half of all sites were rated Poor or Very Poor and about one eighth were rated Good. Good sites were sampled on Wills Branch and two unnamed tributaries. Results compare well with those of MBSS.
Potomac River Lower North Branch	0	NA
Rock Creek/Cabin John Creek	15	All sites were in the Cabin John Creek drainage and all were rated Very Poor. Two MBSS sites in the Cabin John Creek drainage were rated Poor.
St. Mary’s River	4	All sites were clustered in a tributary near Great Mills and all were rated Fair. No MBSS samples were collected in this tributary.
Tuckahoe Creek	0	NA
West Chesapeake Bay	0	NA

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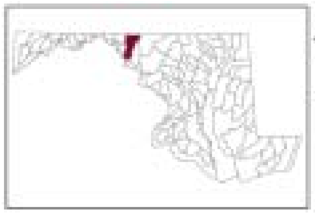
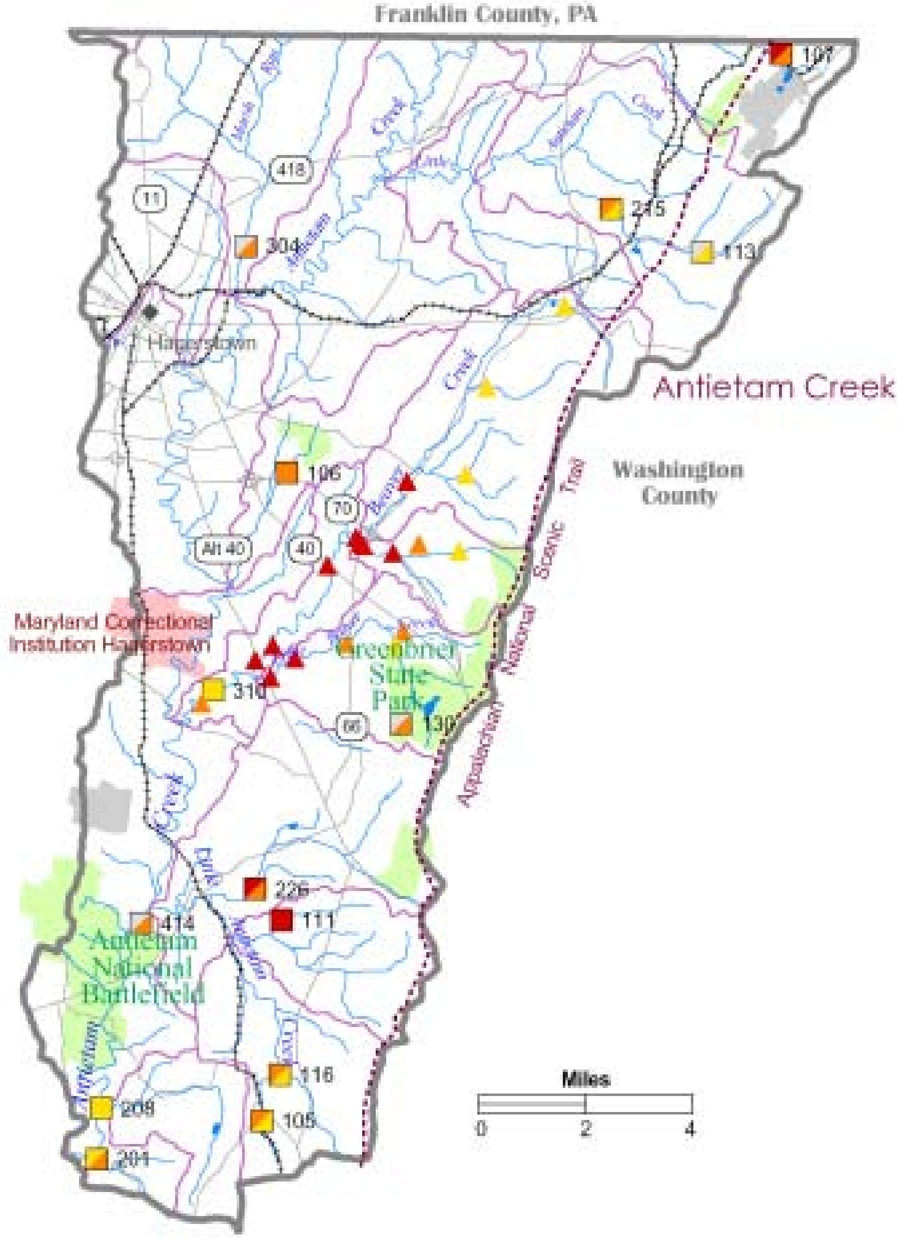
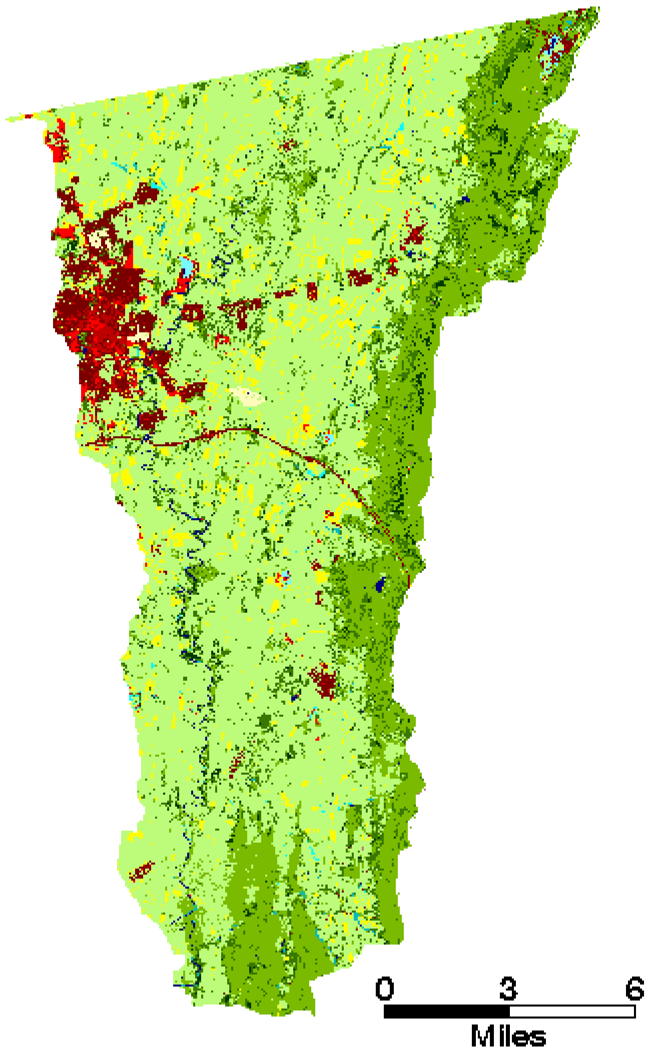
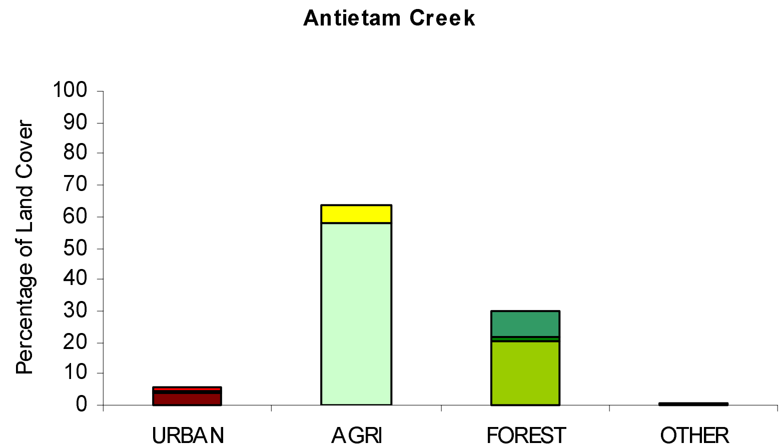


Antietam Creek watershed
MBSS 2003



Antietam Creek





Antietam Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
ANTI-105-R-2003	LITTLE ANTIETAM CR (1) UT2	021405020189	Antietam Creek	UPPER POTOMAC RIVER	Washington	5-Mar-03	15-Jul-03	1	629
ANTI-106-R-2003	LANDIS SPRING BR	021405020196	Antietam Creek	UPPER POTOMAC RIVER	Washington	5-Mar-03	21-Jul-03	1	2258
ANTI-107-R-2003	FALLS CR	021405020205	Antietam Creek	UPPER POTOMAC RIVER	Washington	4-Mar-03	30-Jun-03	1	1807
ANTI-111-R-2003	DOG CR UT1	021405020190	Antietam Creek	UPPER POTOMAC RIVER	Washington	17-Mar-03	16-Jul-03	1	803
ANTI-113-R-2003	LITTLE ANTIETAM CR	021405020201	Antietam Creek	UPPER POTOMAC RIVER	Washington	4-Mar-03	30-Jun-03	1	1439
ANTI-116-R-2003	LITTLE ANTIETAM CR (1) UT2	021405020189	Antietam Creek	UPPER POTOMAC RIVER	Washington	17-Mar-03	15-Jul-03	1	1248
ANTI-130-R-2003	LITTLE BARBER CREEK UT	021405020192	Antietam Creek	UPPER POTOMAC RIVER	Washington	30-Apr-03	17-Jun-03	1	82
ANTI-201-R-2003	ANTIETAM CR UT2	021405020188	Antietam Creek	UPPER POTOMAC RIVER	Washington	11-Mar-03	22-Jul-03	2	1040
ANTI-208-R-2003	SHARMANS BR	021405020188	Antietam Creek	UPPER POTOMAC RIVER	Washington	5-Mar-03	28-Jul-03	2	3438
ANTI-215-R-2003	ANTIETAM CR UT	021405020201	Antietam Creek	UPPER POTOMAC RIVER	Washington	30-Apr-03	30-Jun-03	2	4301
ANTI-226-R-2003	LITTLE ANTIETAM CR	021405020191	Antietam Creek	UPPER POTOMAC RIVER	Washington	17-Mar-03	15-Jul-03	2	3782
ANTI-304-R-2003	MARSH RUN	021405020202	Antietam Creek	UPPER POTOMAC RIVER	Washington	30-Apr-03	21-Sep-03	3	18846
ANTI-310-R-2003	BEAVER CR	021405020195	Antietam Creek	UPPER POTOMAC RIVER	Washington	5-Mar-03	4-Aug-03	3	21198
ANTI-414-R-2003	ANTIETAM CREEK	021405020188	Antietam Creek	UPPER POTOMAC RIVER	Washington	30-Apr-03	21-Sep-03	4	179257

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
ANTI-105-R-2003	2.43	3.22	83.22	0	0
ANTI-106-R-2003	2.14	2.78	66.14	0	0
ANTI-107-R-2003	1.86	2.56	87.99	0	0
ANTI-111-R-2003	1.29	1.89	61.57	0	0
ANTI-113-R-2003	NR	3.44	83.5	1	0
ANTI-116-R-2003	2.43	3.00	45.45	0	0
ANTI-130-R-2003	NR	2.33	92.22	0	0
ANTI-201-R-2003	3.00	2.56	60.5	0	0
ANTI-208-R-2003	3.29	3.89	75.1	0	0
ANTI-215-R-2003	2.14	3.89	76.9	0	0
ANTI-226-R-2003	1.86	2.11	61.72	0	0
ANTI-304-R-2003	NS	2.56	NS	NS	NS
ANTI-310-R-2003	3.29	3.67	47.68	0	0
ANTI-414-R-2003	NS	2.78	NS	NS	NS

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
ANTI-105-R-2003	0.11	31.13	68.12	0.64	0.03
ANTI-106-R-2003	0.41	95.94	3.59	0.07	0.13
ANTI-107-R-2003	9.84	10.26	75.01	4.88	6.34
ANTI-111-R-2003	0.08	84.97	14.92	0.03	0.05
ANTI-113-R-2003	0.03	26.12	73.73	0.12	0.02
ANTI-116-R-2003	0.18	45.79	53.48	0.55	0.04
ANTI-130-R-2003	0.00	0.00	100.00	0.00	0.00
ANTI-201-R-2003	0.09	33.15	66.76	0.00	0.02
ANTI-208-R-2003	0.06	23.94	75.65	0.35	0.02
ANTI-215-R-2003	0.04	19.09	80.49	0.38	0.03
ANTI-226-R-2003	4.24	44.06	51.25	0.45	1.39
ANTI-304-R-2003	2.85	90.14	6.58	0.43	1.27
ANTI-310-R-2003	2.14	52.62	44.55	0.69	1.09
ANTI-414-R-2003	20.05	37.31	37.69	4.96	8.46
Overall PSU					

Antietam Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (µeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
ANTI-105-R-2003	6.98	73.6	255.2	6.019	0.883	9.685	0.0566	0.005	0.0038	0.009	1.022	3.029	7.60	8.00
ANTI-106-R-2003	7.70	616.0	4975.4	15.034	4.716	65.299	0.0425	0.037	0.0082	0.020	4.984	1.399	7.90	22.00
ANTI-107-R-2003	7.83	395.5	976.1	80.946	2.876	13.973	0.0743	0.045	0.0061	0.018	3.023	2.005	8.00	1.10
ANTI-111-R-2003	8.69	309.5	1907.4	21.582	4.129	19.562	0.0659	0.025	0.0243	0.007	4.677	2.696	6.90	16.00
ANTI-113-R-2003	7.59	348.2	505.5	77.546	2.638	13.741	0.0095	0.003	0.0020	0.003	2.712	1.245	8.50	2.90
ANTI-116-R-2003	8.10	104.2	379.0	9.094	1.229	11.888	0.0249	0.004	0.0028	0.004	1.467	2.163	7.70	5.30
ANTI-130-R-2003	5.83	37.3	37.5	4.296	0.055	6.126	0.0081	0.001	0.0004	0.003	0.121	1.385	7.30	3.50
ANTI-201-R-2003	7.74	291.8	2409.3	8.409	2.014	14.670	0.0122	0.005	0.0004	0.004	2.142	2.014	8.30	1.30
ANTI-208-R-2003	7.74	203.2	1390.1	14.129	0.826	11.903	0.0198	0.001	0.0021	0.004	0.965	2.531	7.70	1.30
ANTI-215-R-2003	8.17	158.7	473.6	24.473	0.671	11.799	0.0108	0.001	0.0023	0.006	0.746	1.399	7.90	0.50
ANTI-226-R-2003	8.71	320.9	1287.7	50.439	1.803	14.200	0.1036	0.015	0.0278	0.112	2.345	2.335	6.50	2.50
ANTI-304-R-2003	8.22	632.8	5205.4	22.237	6.894	29.184	0.0300	0.001	0.0242	0.010	8.834	1.090	NS	NS
ANTI-310-R-2003	8.10	518.7	3456.1	46.235	4.571	24.144	0.0397	0.007	0.0139	0.022	4.785	1.370	8.20	3.20
ANTI-414-R-2003	8.09	493.0	3642.0	27.970	4.418	23.373	0.0619	0.016	0.0194	0.026	4.464	1.321	NS	NS

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
ANTI-105-R-2003	50	50	FR	FR	12	11	11	14	40	11	40	40	94	20	52
ANTI-106-R-2003	50	50	FR	FR	10	3	7	8	55	15	20	65	94	18	37
ANTI-107-R-2003	50	50	FR	FR	20	18	17	20	32	18	58	30	93	20	102
ANTI-111-R-2003	50	50	OF	OF	14	5	12	12	39	11	40	60	65	15	72
ANTI-113-R-2003	50	50	FR	FR	14	14	10	12	52	16	63	35	97	20	48
ANTI-116-R-2003	0	0	PA	PA	15	12	11	12	55	15	24	35	65	16	68
ANTI-130-R-2003	50	50	FR	FR	7	11	5	4	15	8	47	35	98	20	12
ANTI-201-R-2003	22	20	HO	PV	12	11	9	8	34	11	49	35	86	14	44
ANTI-208-R-2003	50	50	FR	FR	7	9	7	7	62	12	19	30	92	19	38
ANTI-215-R-2003	50	50	LN	FR	13	16	10	7	52	14	42	35	65	19	32
ANTI-226-R-2003	0	0	CP	PA	17	12	15	20	57	16	33	45	75	17	150
ANTI-304-R-2003	50	0	OF	PA	NS	NS	NS	NS	NS	NS	NS	NS	NS	17	NS
ANTI-310-R-2003	0	0	PA	PA	18	8	17	18	65	20	65	45	60	15	76
ANTI-414-R-2003	18	50	PA	FR	NS	NS	NS	NS	NS	NS	NS	NS	NS	18	NS

Antietam Creek

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
ANTI-105-R-2003	N	N	N	N	Mild	Mild	Moderate
ANTI-106-R-2003	N	N	N	N	Moderate	Moderate	Extensive
ANTI-107-R-2003	N	N	N	N	None	None	Minor
ANTI-111-R-2003	N	N	N	N	Moderate	Moderate	Minor
ANTI-113-R-2003	N	N	N	N	None	None	Minor
ANTI-116-R-2003	Y	N	N	Y	Mild	None	Minor
ANTI-130-R-2003	N	N	N	N	None	None	None
ANTI-201-R-2003	N	N	N	Y	Mild	None	Minor
ANTI-208-R-2003	N	N	N	N	Mild	Mild	Minor
ANTI-215-R-2003	N	N	N	N	None	None	Minor
ANTI-226-R-2003	Y	N	N	N	Moderate	Moderate	Moderate
ANTI-304-R-2003	Y	N	N	N	NS	NS	NS
ANTI-310-R-2003	Y	N	N	N	Mild	Mild	Minor
ANTI-414-R-2003	N	N	N	N	NS	NS	NS

Summary of Watershed Condition

- Some watersheds highly agricultural
- High nitrate and total phosphorus at several sites
- No riparian buffer at four sites

Antietam Creek

Fish Species Present

BLACKNOSE DACE
BLUE RIDGE SCULPIN
BLUEGILL
BLUNTNOSE MINNOW
BROOK TROUT
BROWN TROUT
CHANNEL CATFISH
CHECKERED SCULPIN
COMMON CARP
COMMON SHINER
CREEK CHUB
CUTLIPS MINNOW
FALLFISH
FANTAIL DARTER
GOLDEN REDHORSE
GREEN SUNFISH
GREENSIDE DARTER
LARGEMOUTH BASS
LONGEAR SUNFISH
LONGNOSE DACE
NORTHERN HOGSUCKER
PEARL DACE
POTOMAC SCULPIN
PUMPKINSEED
RAINBOW DARTER
RAINBOW TROUT
REDBREAST SUNFISH
RIVER CHUB
SPOTFIN SHINER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present

MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM

Benthic Taxa Present

ACENTRELLA
ACRONEURIA
AGABUS
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANTOCHA
BAETIDAE
BAETIS
BEZZIA
BRILLIA
CAECIDOTEA
CAENIS
CAMBARIDAE
CAPNIIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMINAE
CHIRONOMINI
CHRYSOPS
CLINOCERA
CLIOPERLA
CORBICULA
CORYNONEURA
CRANGONYX
CRICOTOPUS
CRYPTOCHIRONOMUS
DIAMESA
DIAMESINAE
DICROTENDIPES
DIPLECTRONA
DIPLOCLADIUS
DOLOPHILODES
DUGESIA
ECCOPTURA
ELMIDAE
ENCHYTRAEIDAE
EPHEMERA
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
FERRISSIA
GAMMARUS
GOMPHIDAE
GORDIIDAE
HELENIELLA
HETEROTRISSOCLADIUS
HEXATOMA
HYDROBAENUS
HYDROPHILIDAE
HYDROPORUS
HYDROPSYCHE
HYDROPSYCHIDAE
IRONOQUIA
ISONYCHIA
ISOPERLA
KRENOPELOPIA
LEPTOPHLEBIIDAE
LEUCTRA
LEUCTRIDAE
LIMONIA
LIRCEUS
LUMBRICULIDAE
MICROPSECTRA
MICROTENDIPES
MOLOPHILUS
NAIDIDAE
NANOCLADIUS
NATARSIA
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OPTIOSERVUS
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PAGASTIA
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PERICOMA
PERLIDAE
PERLODIDAE
PHYSELLA
PLANARIIDAE
PLANORBIDAE
POLYCENTROPODIDAE
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PTERONARCYS
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SERRATELLA
SIALIS
SIMULIIDAE
SIMULIUM
SMITTIA
SPHAERIIDAE
SPHAERIUM
STAGNICOLA
STEGOPTERNA
STEMPELLINELLA
STENACRON
STENELMIS
STENONEMA
STILOCLADIUS
STROPHOPTERYX
SYMPOSIOCLADIUS
SYMPOTTHASTIA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TUBIFICIDAE
TVETENIA
WORMALDIA
ZAVRELIMYIA

Herpetofauna Present

BULLFROG
COMMON SNAPPING TURTLE
GREEN FROG
NORTHERN DUSKY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
RED SALAMANDER

Antietam Creek

Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
194-1-2003	Antietam Creek	Beaver Cr.	1.29
194-2-2003	Antietam Creek	Beaver Cr.	1.29
195-2-2003	Antietam Creek	Beaver Cr.	1.29
195-3-2003	Antietam Creek	Beaver Cr.	1.29
195-4-2003	Antietam Creek	Beaver Cr.	1.29
195-5-2003	Antietam Creek	Beaver Cr.	1.29
195-1-2003	Antietam Creek	Beaver Cr.	2.43
194-5-2003	Antietam Creek	Beaver Cr.	3.29
194-4-2003	Antietam Creek	Beaver Cr. UT	3.29
193-2-2003	Antietam Creek	Black Rock Cr.	1.00
193-1-2003	Antietam Creek	Black Rock Cr.	1.86
193-4-2003	Antietam Creek	Black Rock Cr.	2.43
193-3-2003	Antietam Creek	Black Rock Cr.	3.86
192-1-2003	Antietam Creek	Little Beaver Cr.	1.00
192-2-2003	Antietam Creek	Little Beaver Cr.	1.00
192-5-2003	Antietam Creek	Little Beaver Cr.	2.43
192-3-2003	Antietam Creek	Little Beaver Cr.	3.00
192-4-2003	Antietam Creek	Little Beaver Cr. UT	2.71
194-3-2003	Antietam Creek	Mount Aetna Cr.	3.29

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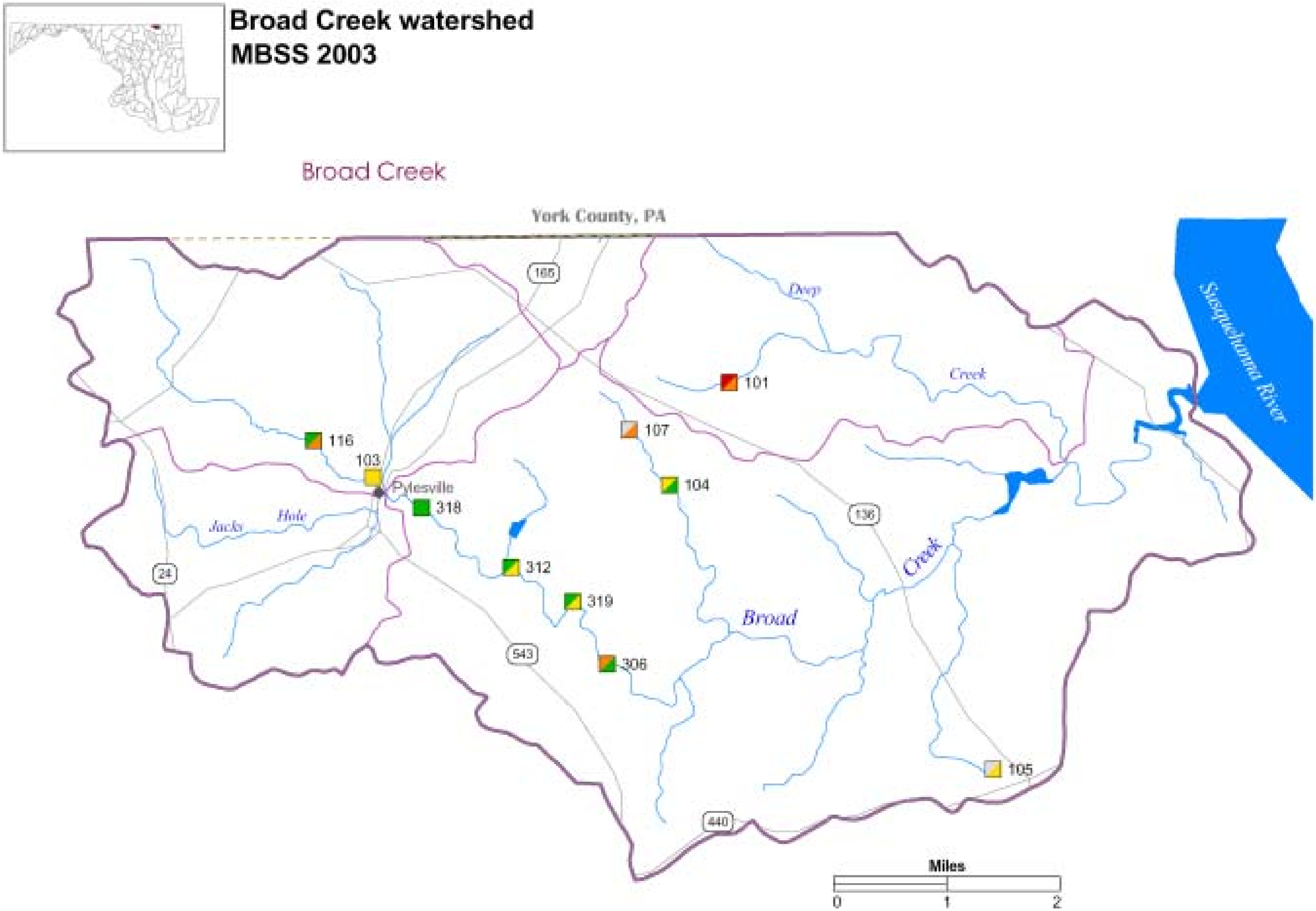
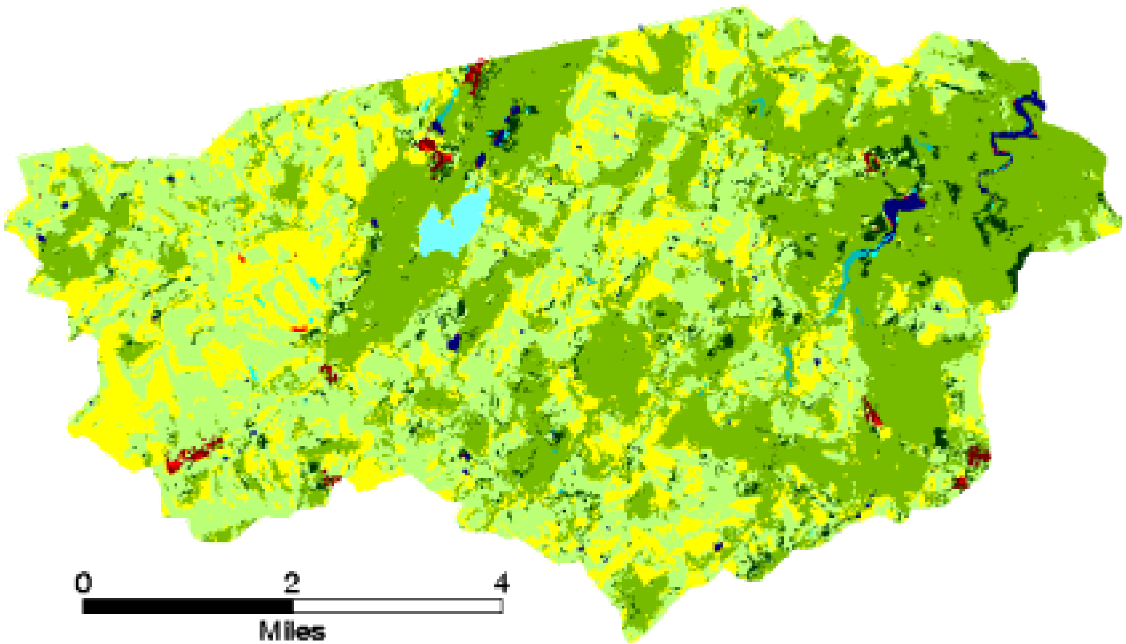
Broad Creek watershed
MBSS 2003



Broad Creek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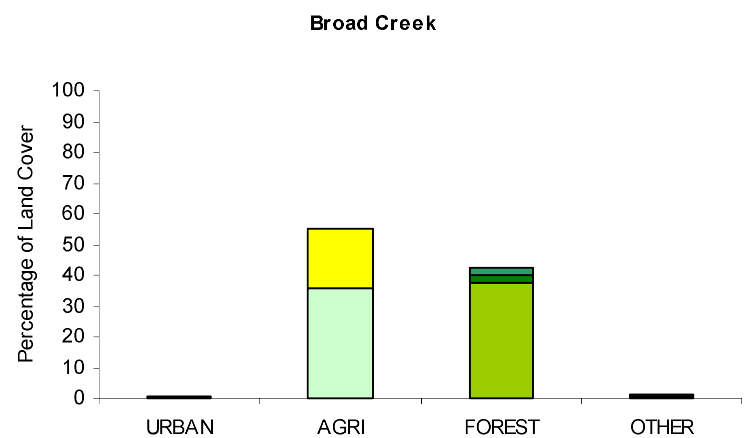

Broad Creek
Percentage of Land Cover
100
90
80
70
60
50
40
30
20
10
0
URBAN
AGRI
FOREST
OTHER

Broad Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
BROA-101-R-2003	DEEP CR	021202050340	Broad Creek	SUSQUEHANNA RIVER	Harford	11-Mar-03	10-Jun-03	1	625
BROA-103-R-2003	BROAD CR	021202050343	Broad Creek	SUSQUEHANNA RIVER	Harford	1-Apr-03	10-Jun-03	1	2121
BROA-104-R-2003	BROAD CR UT5	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	11-Mar-03	11-Jun-03	1	783
BROA-105-R-2003	BROAD CR UT6	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	1-Apr-03	10-Jun-03	1	87
BROA-107-R-2003	BROAD CR UT5	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	11-Mar-03	11-Jun-03	1	167
BROA-116-R-2003	BROAD CR	021202050343	Broad Creek	SUSQUEHANNA RIVER	Harford	1-Apr-03	11-Jun-03	1	1923
BROA-306-R-2003	BROAD CR	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	1-Apr-03	28-Jul-03	3	9821
BROA-312-R-2003	BROAD CR	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	11-Mar-03	29-Jul-03	3	8063
BROA-318-R-2003	BROAD CR	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	1-Apr-03	29-Jul-03	3	4729
BROA-319-R-2003	BROAD CR	021202050339	Broad Creek	SUSQUEHANNA RIVER	Harford	11-Mar-03	28-Jul-03	3	9203

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
BROA-101-R-2003	1.44	2.56	65.89	0	0
BROA-103-R-2003	3.67	3.89	67.05	0	0
BROA-104-R-2003	3.00	4.11	66.82	0	0
BROA-105-R-2003	NR	3.22	74.62	0	0
BROA-107-R-2003	NR	2.11	80.45	0	0
BROA-116-R-2003	4.11	2.56	74.97	0	0
BROA-306-R-2003	4.11	4.11	75.97	0	0
BROA-312-R-2003	4.33	3.67	67.97	0	0
BROA-318-R-2003	4.56	4.11	76.46	0	0
BROA-319-R-2003	4.33	3.89	84.66	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
BROA-101-R-2003	0.04	50.28	49.11	0.57	0.01
BROA-103-R-2003	0.32	78.69	20.51	0.48	0.22
BROA-104-R-2003	0.00	59.37	26.56	14.07	0.00
BROA-105-R-2003	10.86	56.57	32.07	0.51	3.72
BROA-107-R-2003	0.00	33.20	48.74	18.06	0.00
BROA-116-R-2003	0.14	77.19	22.30	0.37	0.09
BROA-306-R-2003	0.64	71.17	27.19	1.00	0.24
BROA-312-R-2003	0.77	75.18	23.34	0.71	0.28
BROA-318-R-2003	0.32	71.28	27.39	1.01	0.15
BROA-319-R-2003	0.68	72.61	25.66	1.05	0.25
Overall PSUI					

Summary of Watershed Condition

- High nitrate and TN at all sites
- TP high at some sites
- ANC low at some sites
- Some sites highly turbid
- 0 riparian buffer at one site

Broad Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
BROA-101-R-2003	6.63	122.4	160.1	18.674	3.713	5.210	0.0664	0.044	0.0054	0.107	3.902	1.200	8.10	13.00
BROA-103-R-2003	6.92	162.9	300.9	22.911	4.197	9.286	0.0208	0.003	0.0051	0.010	4.367	1.030	9.70	5.50
BROA-104-R-2003	6.48	127.4	153.9	21.994	3.694	3.942	0.0096	0.004	0.0004	0.005	3.734	0.881	9.30	2.30
BROA-105-R-2003	7.22	408.8	818.4	21.408	1.196	13.888	0.0235	0.003	0.0037	0.006	1.425	4.072	7.50	6.90
BROA-107-R-2003	6.49	149.6	72.6	31.646	3.284	2.950	0.0044	0.001	0.0004	0.002	3.380	0.970	9.30	1.60
BROA-116-R-2003	7.08	156.1	284.3	23.000	3.676	8.492	0.0190	0.002	0.0053	0.016	3.789	0.946	8.90	6.70
BROA-306-R-2003	7.13	163.7	294.5	23.088	4.417	8.014	0.0148	0.001	0.0055	0.003	4.532	1.276	8.20	6.10
BROA-312-R-2003	6.83	169.4	274.0	24.509	4.704	8.321	0.0373	0.008	0.0045	0.043	4.975	1.379	8.10	8.10
BROA-318-R-2003	6.75	185.3	325.0	26.212	4.821	9.514	0.0158	0.001	0.0046	0.004	5.113	1.175	9.10	5.70
BROA-319-R-2003	6.97	159.4	263.0	22.878	4.524	7.705	0.0256	0.009	0.0047	0.037	4.773	1.274	8.50	9.10

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
BROA-101-R-2003	50	45	FR	CR	12	11	8	10	38	12	42	50	95	11	48
BROA-103-R-2003	0	0	CP	CP	14	15	16	14	30	16	60	25	70	18	68
BROA-104-R-2003	50	40	LN	PV	16	13	16	14	30	14	50	35	98	14	62
BROA-105-R-2003	50	50	OF	FR	16	17	7	4	41	11	36	25	95	16	24
BROA-107-R-2003	20	50	PA	OF	15	14	9	9	24	16	75	6	94	13	45
BROA-116-R-2003	2	50	CP	OF	17	16	17	16	35	16	50	20	88	15	72
BROA-306-R-2003	50	50	FR	FR	16	17	16	13	40	18	75	10	92	16	57
BROA-312-R-2003	20	15	CR	PA	18	18	17	14	48	18	50	30	55	12	80
BROA-318-R-2003	20	50	PV	FR	19	19	18	15	22	19	66	5	80	9	56
BROA-319-R-2003	50	50	OF	FR	15	16	15	17	32	16	50	11	87	16	117

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
BROA-101-R-2003	N	N	N	N	Moderate	Moderate	Moderate
BROA-103-R-2003	N	N	N	N	Moderate	Moderate	Minor
BROA-104-R-2003	N	N	N	N	Mild	Mild	Minor
BROA-105-R-2003	N	N	N	N	Mild	Mild	Minor
BROA-107-R-2003	N	N	N	N	None	Mild	Minor
BROA-116-R-2003	Y	N	N	N	Moderate	Moderate	Minor
BROA-306-R-2003	N	N	N	N	Mild	None	Minor
BROA-312-R-2003	Y	N	N	Y	Mild	Moderate	Minor
BROA-318-R-2003	N	N	N	N	None	Mild	Minor
BROA-319-R-2003	N	N	N	N	Moderate	None	Minor

Broad Creek

Fish Species Present
BLACKNOSE DACE
BLUEGILL
BLUNTNOSE MINNOW
BROWN BULLHEAD
CENTRAL STONEROLLER
COMMON SHINER
CREEK CHUB
CUTLIPS MINNOW
FALLFISH
GREEN SUNFISH
LARGEMOUTH BASS
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
PUMPKINSEED
REDBREAST SUNFISH
RIVER CHUB
ROCK BASS
ROSYFACE SHINER
ROSYSIDE DACE
SHIELD DARTER
SMALLMOUTH BASS
SPOTFIN SHINER
SPOTTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM
BAMBOO

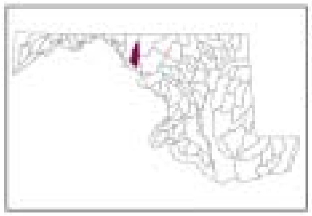
Benthic Taxa Present
ACERPENNA
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
ANTHOPOTAMUS
ANTOCHA
BEZZIA
CAPNIIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMINI
CHIRONOMUS
CONCHAPELOPIA
CORYDALUS
CORYNONEURA
CRICOTOPUS
CURA
DIAMESA
DIAMESINAE
DICRANOTA
DICROTENDIPES
DIPLECTRONA
DUGESIA
ECTOPRIA
ENCHYTRAEIDAE
EPEORUS
EPHEMERA
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
EURYLOPHELLA
GLOSSOSOMATIDAE
GOERA
GOMPHIDAE
HEMERODROMIA
HEPTAGENIIDAE
HEXATOMA
HYDROBAENUS
HYDROPSYCHE
HYDROPSYCHIDAE
ISONYCHIA
LIMNEPHILIDAE
LUMBRICULIDAE
LYPE
MEROPELOPIA
MICROPSECTRA
MICROTENDIPES
NAIDIDAE
NATARSIA
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PHILOPOTAMIDAE
PLANARIIDAE
POLYPEDILUM
PROBEZZIA
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PSYCHOMYIA
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SERRATELLA
SIALIS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
SPIROSPERMA
STEGOPTERNA
STENACRON
STENELMIS
STENONEMA
STROPHOPTERYX
STYGONECTES
SYMPOTTHASTIA
TAENIOPTERYX
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present
AMERICAN TOAD
EASTERN BOX TURTLE
EASTERN PAINTED TURTLE
FOWLER'S TOAD
GREEN FROG
NORTHERN TWO-LINED SALAMANDER
PICKEREL FROG
RED SALAMANDER

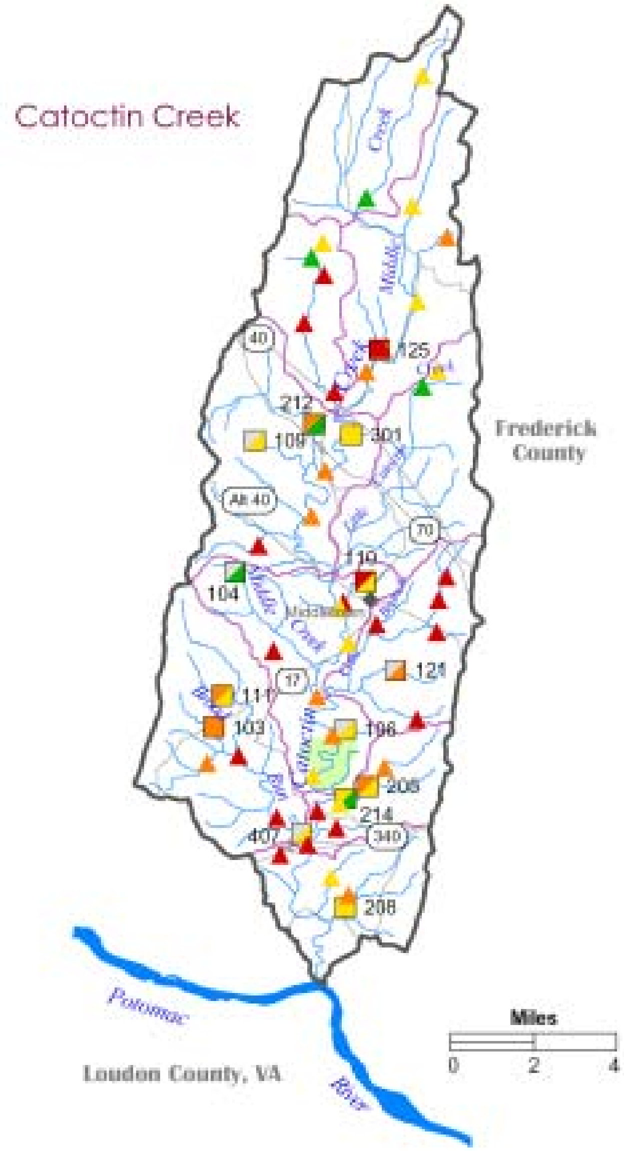
Broad Creek

Stream Waders Data

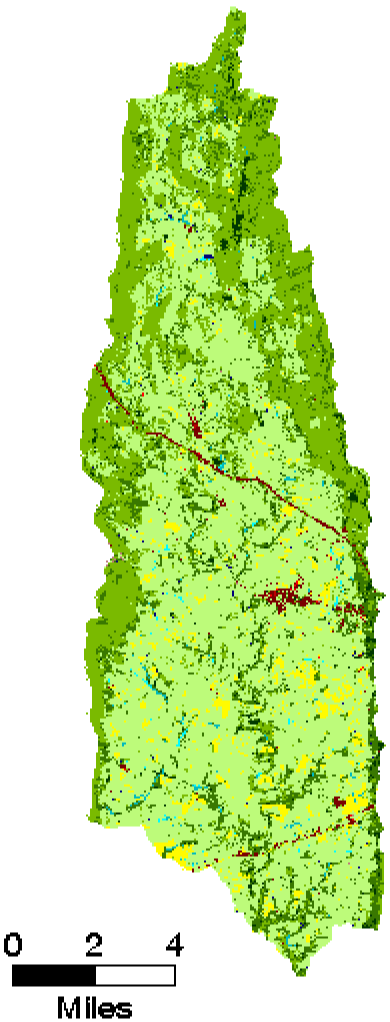
No Stream Waders data collected in 2003

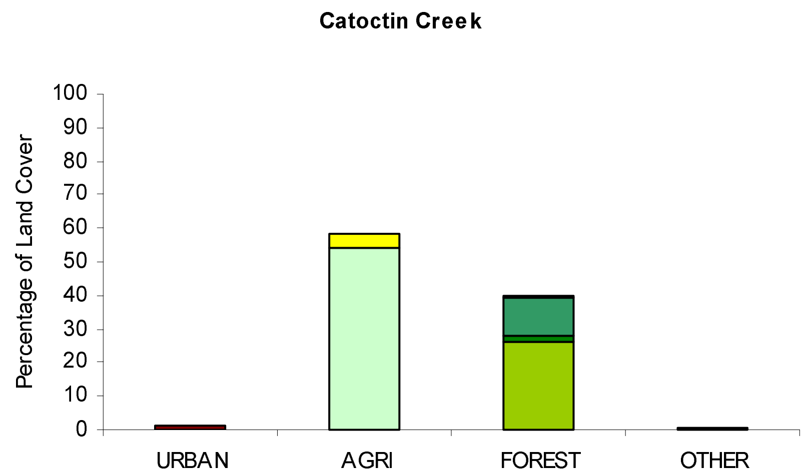


Catoctin Creek watershed
MBSS 2003



Catoctin Creek





Catoctin Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
CATO-103-R-2003	MANOR RUN	021403050214	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	16-Jul-03	1	733
CATO-104-R-2003	MIDDLE CR (CATOCTIN)	021403050215	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	17-Mar-03	16-Jul-03	1	225
CATO-106-R-2003	CATOCTIN CR UT4	021403050215	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	2-Jul-03	1	221
CATO-109-R-2003	CATOCTIN CR UT3	021403050218	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	18-Mar-03	23-Jul-03	1	100
CATO-110-R-2003	CATOCTIN CR UT1	021403050215	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	18-Mar-03	22-Jul-03	1	391
CATO-111-R-2003	BROAD RUN (MP) UT1	021403050214	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	18-Mar-03	16-Jul-03	1	783
CATO-121-R-2003	DEER SPRINGS BR UT1	021403050216	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	10-Sep-03	1	1023
CATO-125-R-2003	WEST BR (MP) UT1	021403050219	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	11-Mar-03	23-Jul-03	1	737
CATO-205-R-2003	LEWIS MILL BR	021403050213	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	27-Aug-03	2	2334
CATO-208-R-2003	CATOCTIN CR UT5	021403050212	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	19-Aug-03	2	2366
CATO-212-R-2003	GRINDSTONE RUN	021403050218	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	2-Jul-03	2	3467
CATO-214-R-2003	LEWIS MILL BR	021403050213	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	10-Mar-03	25-Jun-03	2	2803
CATO-301-R-2003	CATOCTIN CR	021403050218	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	8-Apr-03	4-Aug-03	3	22033
CATO-407-R-2003	CATOCTIN CR	021403050213	Catoctin Creek	MIDDLE POTOMAC RIVER	Frederick	8-Apr-03	21-Sep-03	4	3316

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
CATO-103-R-2003	2.14	2.56	72.05	0	0
CATO-104-R-2003	NR	4.56	89.88	0	0
CATO-106-R-2003	NR	3.00	84.26	0	0
CATO-109-R-2003	NR	3.67	92.22	0	0
CATO-110-R-2003	1.00	3.89	56.21	0	0
CATO-111-R-2003	2.14	3.67	53.19	0	0
CATO-121-R-2003	NS	2.78	NS	NS	NS
CATO-125-R-2003	1.00	2.11	51.24	0	0
CATO-205-R-2003	2.14	3.89	73.72	0	0
CATO-208-R-2003	3.29	3.89	75.14	0	0
CATO-212-R-2003	2.43	4.33	66.78	0	0
CATO-214-R-2003	3.57	4.11	55.22	0	0
CATO-301-R-2003	3.86	3.89	73.91	0	0
CATO-407-R-2003	NS	3.22	NS	NS	NS

Catchment Land Use

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
CATO-103-R-2003	0.09	70.91	28.84	0.15	0.02
CATO-104-R-2003	0.00	0.90	99.10	0.00	0.00
CATO-106-R-2003	0.00	92.73	5.05	2.22	0.00
CATO-109-R-2003	0.45	22.10	77.46	0.00	0.11
CATO-110-R-2003	5.12	91.58	3.24	0.06	1.91
CATO-111-R-2003	0.23	60.53	38.45	0.80	0.06
CATO-121-R-2003	1.26	79.22	18.34	1.18	0.41
CATO-125-R-2003	0.00	76.95	22.71	0.33	0.00
CATO-205-R-2003	0.34	75.97	23.56	0.12	0.14
CATO-208-R-2003	2.67	69.76	26.99	0.58	1.83
CATO-212-R-2003	2.73	36.95	59.94	0.38	1.90
CATO-214-R-2003	1.01	76.45	22.43	0.11	0.30
CATO-301-R-2003	0.22	38.29	61.17	0.32	0.07
CATO-407-R-2003	0.86	74.94	24.07	0.13	0.25
Overall PSU					

Catoctin Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (µeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
CATO-103-R-2003	7.32	260.4	888.9	21.373	6.232	22.014	0.4747	0.299	0.0301	0.513	7.679	5.441	7.80	3.90
CATO-104-R-2003	6.51	38.7	68.7	1.967	0.179	9.216	0.0188	0.003	0.0004	0.004	0.286	1.371	8.80	4.30
CATO-106-R-2003	7.32	236.6	841.2	20.250	5.726	29.700	0.1322	0.101	0.0234	0.093	6.559	2.540	7.70	2.60
CATO-109-R-2003	7.25	106.1	383.5	5.788	1.296	17.891	0.0738	0.009	0.0004	0.003	1.441	0.759	7.40	5.80
CATO-110-R-2003	7.54	296.3	895.9	37.894	3.895	29.272	0.0563	0.020	0.0113	0.007	4.233	1.374	7.30	5.40
CATO-111-R-2003	7.31	144.1	462.1	12.326	3.455	13.692	0.0707	0.035	0.0092	0.008	3.815	2.382	7.30	4.70
CATO-121-R-2003	7.44	270.2	939.5	25.579	4.558	25.739	0.1540	0.076	0.0234	0.217	5.245	2.677	NS	NS
CATO-125-R-2003	7.53	254.8	582.4	30.601	5.265	22.434	0.1053	0.071	0.0103	0.035	5.923	1.692	5.80	8.00
CATO-205-R-2003	7.53	262.7	743.8	22.497	3.852	26.717	0.0579	0.041	0.0037	0.010	4.017	1.176	8.70	3.20
CATO-208-R-2003	7.78	231.9	694.4	24.311	4.030	22.696	0.0533	0.029	0.0061	0.005	4.250	1.301	9.30	3.90
CATO-212-R-2003	7.57	255.0	490.8	85.836	1.593	16.988	0.0259	0.010	0.0018	0.002	1.722	1.423	8.60	1.90
CATO-214-R-2003	7.64	222.8	718.2	21.191	3.435	25.542	0.0577	0.041	0.0035	0.009	3.592	1.138	9.60	3.70
CATO-301-R-2003	8.42	151.3	470.5	19.772	0.894	13.154	0.0191	0.001	0.0032	0.004	0.993	2.027	7.70	2.80
CATO-407-R-2003	8.38	202.4	677.9	26.063	1.531	17.077	0.0569	0.011	0.0087	0.004	1.658	2.172	NS	NS

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
CATO-103-R-2003	38	50	CP	LN	9	7	11	11	55	13	22	40	90	18	51
CATO-104-R-2003	50	50	FR	FR	6	14	6	3	19	7	45	15	98	20	12
CATO-106-R-2003	50	50	FR	FR	9	14	7	7	42	11	33	30	95	20	32
CATO-109-R-2003	50	50	FR	FR	4	11	6	4	33	6	42	30	98	19	10
CATO-110-R-2003	10	17	PA	CP	9	7	8	7	41	11	37	50	96	12	30
CATO-111-R-2003	5	3	CP	PV	16	15	14	14	48	16	28	30	75	9	63
CATO-121-R-2003	0	0	CP	CP	NS	NS	NS	NS	NS	NS	NS	NS	NS	17	NS
CATO-125-R-2003	0	0	PA	PA	15	13	9	9	28	14	47	40	85	12	39
CATO-205-R-2003	50	35	FR	LN	8	14	11	11	42	12	47	35	95	16	61
CATO-208-R-2003	50	0	FR	PA	16	13	10	9	35	16	68	40	75	16	40
CATO-212-R-2003	50	12	LN	CP	12	15	11	11	39	16	51	40	80	19	50
CATO-214-R-2003	0	50	DI	FR	16	12	16	15	45	17	48	40	60	16	59
CATO-301-R-2003	50	50	OF	FR	9	6	8	11	75	0	0	35	90	18	66
CATO-407-R-2003	50	25	FR	PA	NS	NS	NS	NS	NS	NS	NS	NS	NS	17	NS

Catoctin Creek

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
CATO-103-R-2003	N	N	N	N	Mild	Mild	None
CATO-104-R-2003	N	N	N	N	None	None	Minor
CATO-106-R-2003	N	N	N	N	None	None	Minor
CATO-109-R-2003	N	N	N	N	None	None	Minor
CATO-110-R-2003	N	N	N	N	Moderate	Moderate	Moderate
CATO-111-R-2003	Y	N	N	Y	Moderate	None	None
CATO-121-R-2003	Y	N	N	Y	NS	NS	NS
CATO-125-R-2003	Y	N	N	N	None	None	Minor
CATO-205-R-2003	N	N	N	N	None	Severe	Moderate
CATO-208-R-2003	Y	N	N	N	None	None	Moderate
CATO-212-R-2003	N	N	N	N	Moderate	Severe	Moderate
CATO-214-R-2003	Y	N	N	Y	None	None	Minor
CATO-301-R-2003	N	N	N	N	Mild	Mild	None
CATO-407-R-2003	N	N	N	N	NS	NS	NS

Summary of Watershed Condition

- Many site have agricultural catchments
- Nitrogen and phosphorus elevated at most sites
- Chloride high at three sites
- Low riparian buffer at four sites; buffer breaks at 5 sites
- Channelization evident at three sites

Catoctin Creek

Fish Species Present

BLACKNOSE DACE
BLUEGILL
BLUNTNOSE MINNOW
CENTRAL STONEROLLER
COMMON SHINER
CREEK CHUB
CREEK CHUBSUCKER
FALLFISH
FANTAIL DARTER
FATHEAD MINNOW
GOLDEN REDHORSE
GOLDEN SHINER
GREEN SUNFISH
GREENSIDE DARTER
LEPOMIS HYBRID
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
POTOMAC SCULPIN
RAINBOW DARTER
REDBREAST SUNFISH
RIVER CHUB
ROCK BASS
ROSYSIDE DACE
SILVERJAW MINNOW
SPOTFIN SHINER
SPOTTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present

MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM

Benthic Taxa Present

ACRONEURIA
ALLOCAPNIA
AMELETUS
AMPHINEMURA
BAETIDAE
BEZZIA
BITTACOMORPHA
BRILLIA
BRUNDINIELLA
CAECIDOTEA
CAMBARIDAE
CAPNIIDAE
CERATOPOGON
CERATOPOGONIDAE
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMIDAE
CHIRONOMINAE
CHIRONOMINI
CHIRONOMUS
CHRYSOPS
CLINOCERA
CLINOTANYPUS
CLIOPERLA
CONCHAPELOPIA
CORDULEGASTER
CORYNONEURA
CRANGONYX
CRICOTOPUS
CRYPTOCHIRONOMUS
DIAMESA
DIAMESINAE
DIPHETOR
DIPLECTRONA
DIPLOPERLA
DIPTERA
DIXA
DOLICHOPODIDAE
DOLOPHILODES
DRUNELLA
DUGESIA
ELMIDAE
ENCHYTRAEIDAE
EPHEMERA
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
EURYLOPHELLA
FERRISSIA
GAMMARUS
GOMPHIDAE
HELENIELLA
HEMERODROMIA
HEXATOMA
HYDROBAENUS
HYDROPSYCHE
HYDROPSYCHIDAE
ISONYCHIA
ISOPERLA
LEPTOPHLEBIIDAE
LIMNODRILUS
LUMBRICULIDAE
LYPE
MICROCYLLOEPUS
MICROPSECTRA
MICROTENDIPES
MOLOPHILUS
NAIDIDAE
NATARSIA
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PERICOMA
PERLIDAE
PERLODIDAE
PHILOPOTAMIDAE
PHYLOCENTROPUS
PHYSELLA
PISIDIUM
PLECOPTERA
POLYCENTROPUS
POLYPEDILUM
PROBEZZIA
PROSIMULIUM
PROSTOIA
PSEPHENUS
PSEUDOLIMNOPHILA
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SCIRTIDAE
SERRATELLA
SIMULIUM
SPHAERIIDAE
STEGOPTERNA
STEMPELLINA
STEMPELLINELLA
STENACRON
STENELMIS
STENONEMA
STROPHOPTERYX
SYMPOSIOCLADIUS
SYMPOTTHASTIA
TALLAPERLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRICHOPTERA
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present

BULLFROG
GREEN FROG
NORTHERN DUSKY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
RED SALAMANDER

Catoctin Creek

Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
218-4-2003	Catoctin Creek	Bolivar Br.	1.29
214-2-2003	Catoctin Creek	Broad Run	1.29
214-3-2003	Catoctin Creek	Broad Run	1.86
213-2-2003	Catoctin Creek	Catoctin Cr.	1.57
213-3-2003	Catoctin Creek	Catoctin Cr.	1.57
215-2-2003	Catoctin Creek	Catoctin Cr.	2.43
218-3-2003	Catoctin Creek	Catoctin Cr.	2.43
215-16-2003	Catoctin Creek	Catoctin Cr.	2.71
218-2-2003	Catoctin Creek	Catoctin Cr.	2.71
215-1-2003	Catoctin Creek	Catoctin Cr.	3.00
215-12-2003	Catoctin Creek	Catoctin Cr.	3.00
215-15-2003	Catoctin Creek	Catoctin Cr.	3.57
212-3-2003	Catoctin Creek	Catoctin Cr. UT	1.29
213-1-2003	Catoctin Creek	Catoctin Cr. UT	1.86
212-1-2003	Catoctin Creek	Catoctin Cr. UT	2.71
212-2-2003	Catoctin Creek	Catoctin Cr. UT	3.00
216-11-2003	Catoctin Creek	Cone Br.	1.86
216-14-2003	Catoctin Creek	Deer Springs Br.	1.29
216-4-2003	Catoctin Creek	Hollow Cr.	1.00
216-10-2003	Catoctin Creek	Hollow Cr.	1.29
216-17-2003	Catoctin Creek	Hollow Cr. UT	1.29
213-4-2003	Catoctin Creek	Lewis Mill Br.	2.71
213-5-2003	Catoctin Creek	Lewis Mill Br.	3.57
220-2-2003	Catoctin Creek	Little Catoctin Cr.	1.29
220-1-2003	Catoctin Creek	Little Catoctin Cr.	1.86
217-1-2003	Catoctin Creek	Little Catoctin Cr.	4.43
220-5-2003	Catoctin Creek	Little Catoctin Cr. UT	1.29
217-2-2003	Catoctin Creek	Little Catoctin Cr. UT	3.29
220-3-2003	Catoctin Creek	Little Catoctin Cr. UT	3.29
220-4-2003	Catoctin Creek	Little Catoctin Cr. UT	5.00
221-1-2003	Catoctin Creek	Middle Cr.	3.00
219-3-2003	Catoctin Creek	Middle Cr.	3.29
221-2-2003	Catoctin Creek	Middle Cr.	4.14
215-13-2003	Catoctin Creek	Middle Cr. UT	1.86
219-1-2003	Catoctin Creek	Middle Cr. UT	2.14
219-4-2003	Catoctin Creek	Middle Cr. UT	2.43
214-1-2003	Catoctin Creek	Samuels Run	2.43
219-5-2003	Catoctin Creek	Spruce Run	3.57
219-2-2003	Catoctin Creek	West Br.	1.29
215-3-2003	Catoctin Creek	Wiles Br.	1.00

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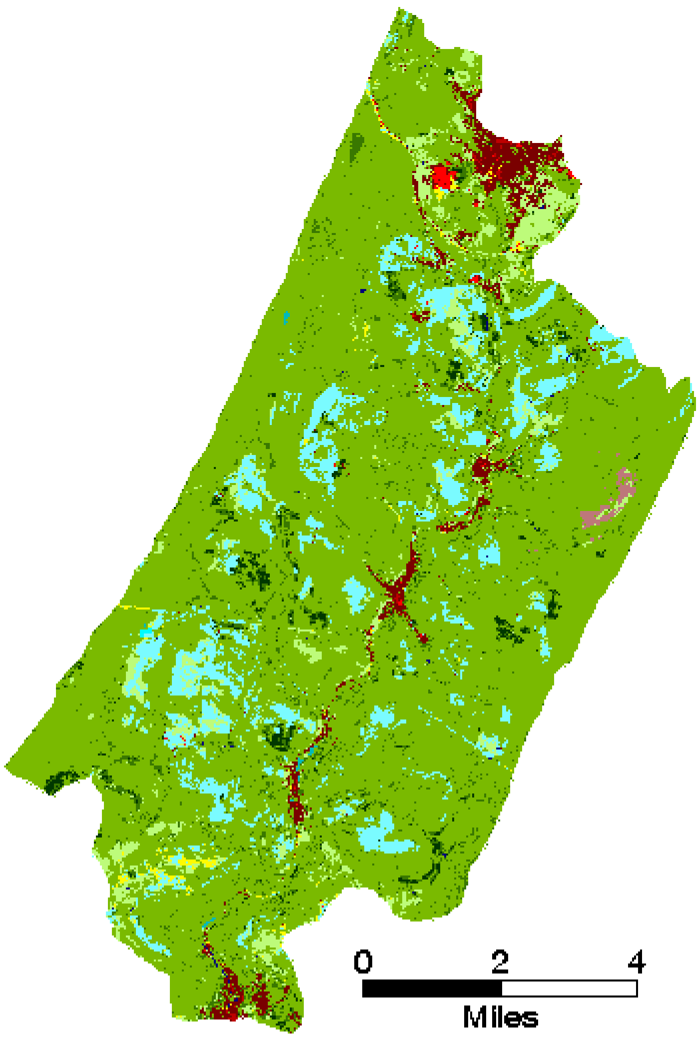
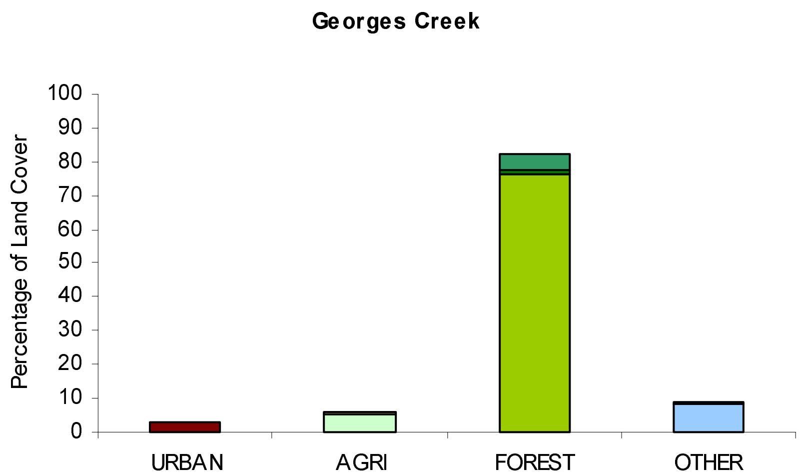
Georges Creek watershed
MBSS 2003

Georges Creek





Georges Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
GEOR-102-R-2003	WINEBRENNER RUN	021410040093	Georges Creek	NORTH BRANCH POTOMAC RIVER	Garrett	1-Apr-03	19-Jun-03	1	547
GEOR-103-R-2003	WINEBRENNER RUN	021410040093	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	19-Jun-03	1	911
GEOR-104-R-2003	NEFF RUN UT1	021410040091	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	19-Jun-03	1	37
GEOR-106-R-2003	MILL RUN (GEOR CR)	021410040087	Georges Creek	NORTH BRANCH POTOMAC RIVER	Garrett	1-Apr-03	11-Aug-03	1	628
GEOR-107-R-2003	ELK LICK RUN	021410040090	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	10-Jul-03	1	609
GEOR-114-R-2003	STAUB RUN	021410040092	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	9-Jul-03	1	1029
GEOR-208-R-2003	SAND SPRING RUN	021410040094	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	9-Jul-03	2	1849
GEOR-209-R-2003	GEORGES CR	021410040094	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	9-Jul-03	2	1781
GEOR-211-R-2003	ELK LICK RUN	021410040090	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	9-Jul-03	2	1713
GEOR-315-R-2003	GEORGES CR	021410040089	Georges Creek	NORTH BRANCH POTOMAC RIVER	Allegany	1-Apr-03	20-Aug-03	3	28435

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
GEOR-102-R-2003	1.00	1.44	90.03	0	0
GEOR-103-R-2003	1.00	3.89	90.3	0	0
GEOR-104-R-2003	NR	3.22	90.99	0	0
GEOR-106-R-2003	1.00	3.44	84.73	0	0
GEOR-107-R-2003	NR	4.11	81.02	1	0
GEOR-114-R-2003	NR	4.11	87.8	1	0
GEOR-208-R-2003	1.29	2.33	66.38	0	0
GEOR-209-R-2003	1.00	2.78	70.42	0	0
GEOR-211-R-2003	1.86	4.78	48.97	0	0
GEOR-315-R-2003	1.29	2.11	67.52	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
GEOR-102-R-2003	0.00	0.24	99.76	0.00	0.00
GEOR-103-R-2003	0.00	0.17	99.83	0.00	0.00
GEOR-104-R-2003	0.00	0.00	97.53	2.47	0.00
GEOR-106-R-2003	0.00	4.72	92.91	2.38	0.00
GEOR-107-R-2003	0.00	3.77	88.01	8.23	0.00
GEOR-114-R-2003	0.00	1.58	97.07	1.34	0.00
GEOR-208-R-2003	5.29	10.46	83.19	1.06	2.21
GEOR-209-R-2003	5.15	10.53	83.22	1.10	2.20
GEOR-211-R-2003	0.00	1.87	93.53	4.59	0.00
GEOR-315-R-2003	4.31	5.62	81.85	8.22	1.45
Overall PSU					

Georges Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
GEOR-102-R-2003	5.40	26.9	1.5	0.955	0.032	8.119	0.0047	0.001	0.0006	0.002	0.098	0.277	9.80	0.20
GEOR-103-R-2003	6.47	30.7	34.4	1.071	0.389	7.605	0.0051	0.001	0.0004	0.002	0.445	0.239	9.90	1.20
GEOR-104-R-2003	6.73	102.6	172.8	4.405	2.622	19.790	0.0133	0.001	0.0004	0.002	2.647	0.389	10.80	0.90
GEOR-106-R-2003	6.31	34.4	22.4	1.367	0.369	9.087	0.0198	0.001	0.0004	0.002	0.450	1.496	9.10	7.40
GEOR-107-R-2003	6.95	47.8	97.5	1.952	0.494	10.823	0.0161	0.001	0.0004	0.002	0.558	0.821	8.20	8.00
GEOR-114-R-2003	6.89	33.0	71.2	0.922	0.596	6.389	0.0069	0.001	0.0004	0.002	0.645	0.210	7.70	3.20
GEOR-208-R-2003	7.20	631.6	173.6	175.102	0.674	23.466	0.0065	0.001	0.0004	0.017	0.752	0.573	7.60	4.50
GEOR-209-R-2003	7.08	658.3	165.4	180.857	0.600	22.952	0.0055	0.001	0.0004	0.010	0.658	0.705	7.60	4.20
GEOR-211-R-2003	7.42	62.6	253.9	2.205	0.491	10.274	0.0166	0.001	0.0004	0.003	0.540	0.322	7.70	4.30
GEOR-315-R-2003	7.61	606.1	687.5	34.304	0.843	208.845	0.0212	0.001	0.0004	0.041	0.913	0.675	8.80	2.50

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
GEOR-102-R-2003	50	50	FR	FR	18	14	14	15	34	17	53	30	90	20	54
GEOR-103-R-2003	50	50	FR	FR	17	16	13	13	12	19	75	45	97	16	49
GEOR-104-R-2003	50	50	FR	FR	7	15	7	4	10	11	71	30	98	20	19
GEOR-106-R-2003	16	50	LO	FR	16	13	8	8	20	14	57	35	95	20	32
GEOR-107-R-2003	50	50	FR	FR	17	12	9	12	23	17	62	35	97	20	44
GEOR-114-R-2003	50	50	FR	FR	13	12	8	11	15	15	70	35	93	19	47
GEOR-208-R-2003	8	17	LN	PK	12	13	9	9	19	16	63	35	95	13	42
GEOR-209-R-2003	12	50	DI	FR	14	12	11	13	24	16	70	35	94	17	50
GEOR-211-R-2003	3	5	PV	LN	13	12	8	7	14	16	75	30	65	11	32
GEOR-315-R-2003	50	37	FR	PV	18	9	15	20	52	16	51	50	80	10	195

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
GEOR-102-R-2003	N	N	N	N	None	None	None
GEOR-103-R-2003	N	Y	N	N	Mild	Mild	Minor
GEOR-104-R-2003	N	Y	N	N	None	None	None
GEOR-106-R-2003	N	N	N	N	None	Mild	Minor
GEOR-107-R-2003	N	N	N	N	Mild	None	Minor
GEOR-114-R-2003	N	N	N	N	Mild	Mild	Minor
GEOR-208-R-2003	N	Y	N	N	None	Mild	Moderate
GEOR-209-R-2003	N	Y	N	N	None	Mild	Minor
GEOR-211-R-2003	Y	N	N	Y	None	None	None
GEOR-315-R-2003	Y	Y	N	Y	None	None	Moderate

Georges Creek

Fish Species Present

BLACKNOSE DACE
BLUE RIDGE SCULPIN
BROOK TROUT
BROWN TROUT
CREEK CHUB
FANTAIL DARTER
RAINBOW TROUT
ROSYSIDE DACE
WHITE SUCKER

Exotic Plants Present

MULTIFLORA ROSE
THISTLE

Benthic Taxa Present

ACRONEURIA
ACRONEURIA
AMELETUS
AMPHINEMURA
ANTOCHA
BRILLIA
CAECIDOTEA
CAMBARIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIRONOMIDAE
CHIRONOMINI
CHLOROPERLIDAE
DIAMESA
DICRANOTA
DIPLECTRONA
DUGESIA
ECTOPRIA
ELMIDAE
ENCHYTRAEIDAE
EPEORUS
EPHEMERELLA
EUKIEFFERIELLA
EURYLOPHELLA
HELENIELLA
HEPTAGENIIDAE
HEXATOMA
HYDROPSYCHE
HYDROPSYCHIDAE
ISOPERLA
ISOTOMURUS
LEPIDOPTERA
LEPIDOSTOMA
LEPTOPHLEBIIDAE
LEUCTRA
LEUCTRIDAE
LUMBRICULIDAE
MICROPSECTRA
MICROTENDIPES
MOLOPHILUS
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORTHOCLADIINAE
OSTROCERCA
OULIMNIUS
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PELTOPERLA
PELTOPERLIDAE
PERLIDAE
PERLODIDAE
PHILOPOTAMIDAE
POLYCENTROPODIDAE
POLYCENTROPUS
PROSIMULIUM
PSEPHENUS
PSEUDOLIMNOPHILA
PTERONARCYS
RHEOCRICOTOPUS
RHYACOPHILA
SOYEDINA
STEGOPTERNA
STEMPELLINELLA
STENACRON
STENONEMA
SWELTSA
SYMPOTTHASTIA
TALLAPERLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TVETENIA
WORMALDIA

Herpetofauna Present

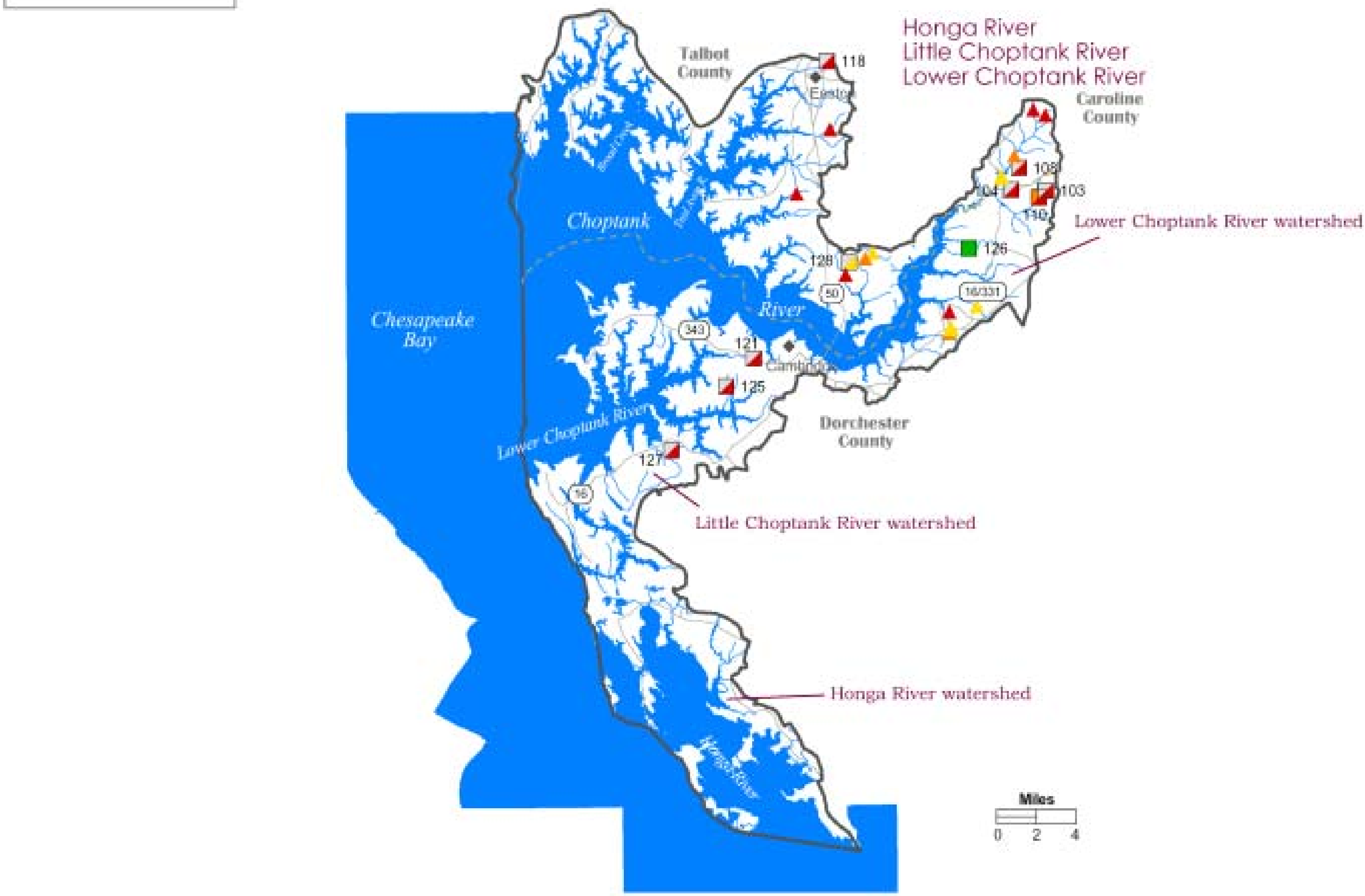
AMERICAN TOAD
GREEN FROG
MOUNTAIN DUSKY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
RED SPOTTED NEWT

Georges Creek

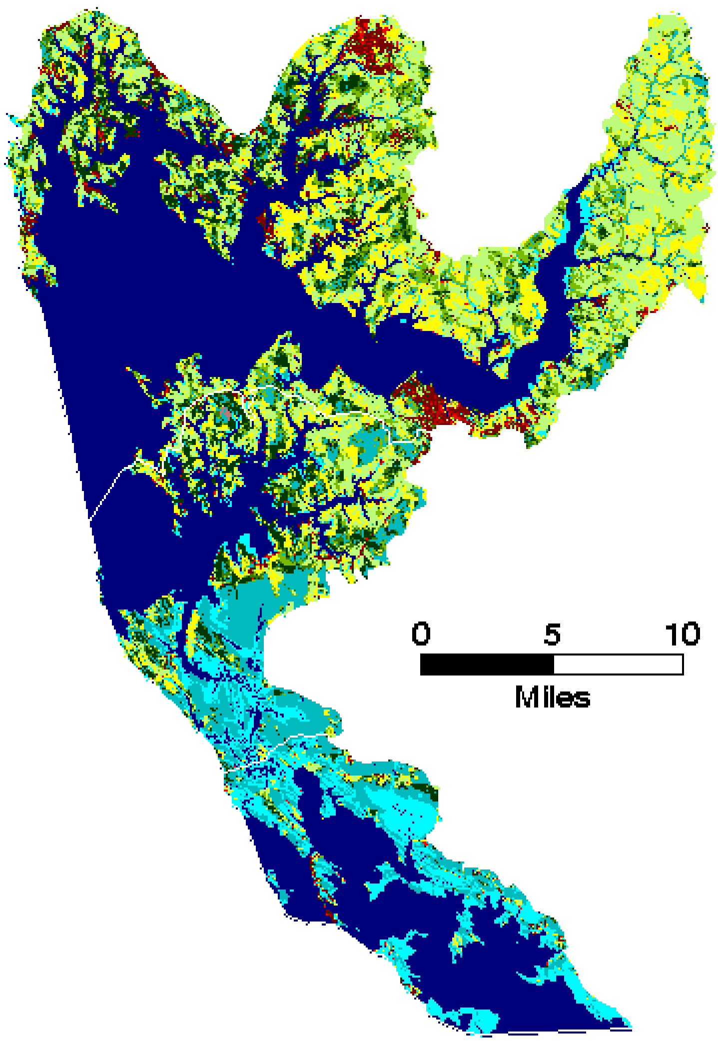
Stream Waders Data

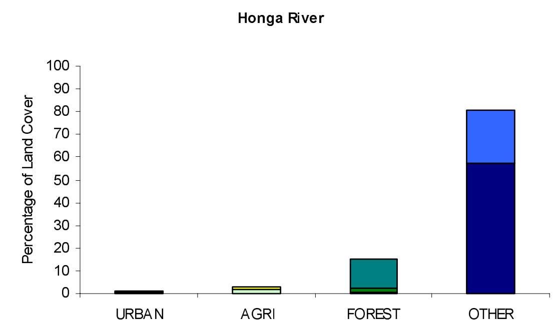
Site	8-digit Watershed	Stream Name	Benthic IBI
94-2-2003	Georges Creek	Georges Cr.	1.00
93-1-2003	Georges Creek	Georges Cr.	1.29
88-2-2003	Georges Creek	Georges Cr. UT	3.00
88-3-2003	Georges Creek	Georges Cr. UT	2.43
87-3-2003	Georges Creek	Michael's Run	3.86
87-1-2003	Georges Creek	Mill Run	1.29
87-2-2003	Georges Creek	Mill Run UT	4.71
88-4-2003	Georges Creek	Moore's Run	1.57
91-1-2003	Georges Creek	Neff Run	2.14

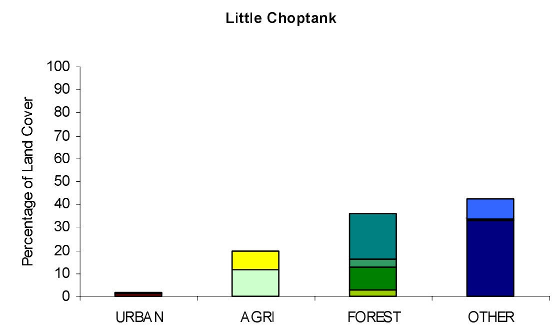
Honga River/Little Choptank River/ Lower Choptank River watersheds MBSS 2003

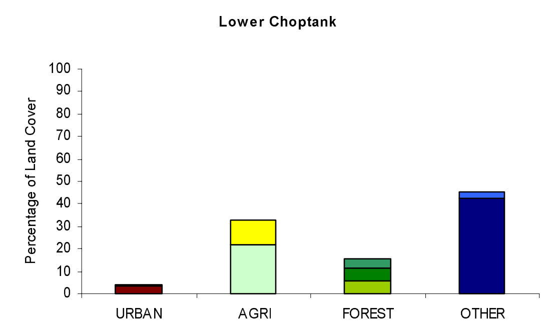


Honga River/Lower Choptank/Little Choptank









Honga River/Lower Choptank/Little Choptank

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
LICK-121-R-2003	UT LEE CREEK	021304020454	LITTLE CHOPTANK	CHOPTANK RIVER	DORCHESTER	3-APR-03	16-JUL-03	1	39
LICK-125-R-2003	UT NORTH EAST BRANCH	021304020452	LITTLE CHOPTANK	CHOPTANK RIVER	DORCHESTER	17-MAR-03	16-JUL-03	1	105
LICK-127-R-2003	UT CORSEY CREEK	021304020450	LITTLE CHOPTANK	CHOPTANK RIVER	DORCHESTER	17-MAR-03	16-JUL-03	1	50
LOCK-103-R-2003	GRAVEL RUN UT1	021304030469	LOWER CHOPTANK	CHOPTANK RIVER	DORCHESTER	19-MAR-03	17-JUL-03	1	165
LOCK-104-R-2003	HUNTING CR (CK) UT2	021304030470	LOWER CHOPTANK	CHOPTANK RIVER	DORCHESTER	19-MAR-03	22-JUL-03	1	136
LOCK-108-R-2003	HUNTING CR (CK) UT1	021304030471	LOWER CHOPTANK	CHOPTANK RIVER	CAROLINE	19-MAR-03	7-JUL-03	1	136
LOCK-110-R-2003	GRAVEL RUN UT1	021304030469	LOWER CHOPTANK	CHOPTANK RIVER	DORCHESTER	19-MAR-03	17-JUL-03	1	346
LOCK-118-R-2003	TANYARD BR	021304030465	LOWER CHOPTANK	CHOPTANK RIVER	TALBOT	17-MAR-03	7-JUL-03	1	34
LOCK-126-R-2003	BLINKHORN CREEK	021304030467	LOWER CHOPTANK	CHOPTANK RIVER	DORCHESTER	17-MAR-03	22-JUL-03	1	1093
LOCK-128-R-2003	BOLINGBROKE CREEK	021304030459	LOWER CHOPTANK	CHOPTANK RIVER	TALBOT	17-MAR-03	22-JUL-03	1	232

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
LICK-121-R-2003	NR	1.00	88.19	0	1
LICK-125-R-2003	NR	1.57	78.72	0	0
LICK-127-R-2003	NR	1.29	82.18	0	1
LOCK-103-R-2003	NR	1.57	68.76	0	1
LOCK-104-R-2003	NR	1.57	68.75	0	0
LOCK-108-R-2003	NR	1.57	71.34	0	0
LOCK-110-R-2003	2.50	1.57	69.62	0	0
LOCK-118-R-2003	NR	1.57	74.68	0	0
LOCK-126-R-2003	4.25	4.43	76.44	0	0
LOCK-128-R-2003	NR	3.00	76.46	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
LICK-121-R-2003	3.98	50.57	45.45	0.00	0.99
LICK-125-R-2003	0.25	48.40	51.11	0.25	0.06
LICK-127-R-2003	0.00	10.27	89.73	0.00	0.00
LOCK-103-R-2003	0.00	78.46	21.54	0.00	0.00
LOCK-104-R-2003	8.26	68.10	23.64	0.00	2.15
LOCK-108-R-2003	0.16	90.77	9.06	0.00	0.04
LOCK-110-R-2003	0.00	78.48	21.39	0.13	0.00
LOCK-118-R-2003	0.66	73.03	26.32	0.00	0.16
LOCK-126-R-2003	0.45	81.16	18.35	0.04	0.13
LOCK-128-R-2003	0.00	78.94	21.06	0.00	0.00
Overall PSU					

Summary of Watershed Condition

- Low ANC throughout watershed
- Elevated nitrogen and phosphorus throughout
- Sulfate and Chloride high at one site
- DOC high and DO low at five sites
- Three sites have high turbidity
- Habitat measures generally poor, most sites 100% embedded

Honga River/Lower Choptank/Little Choptank

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (ueq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
LICK-121-R-2003	4.61	254.2	-10.8	33.393	0.000	68.429	0.0487	0.001	0.0004	0.039	0.439	11.678	0.90	14.40
LICK-125-R-2003	5.96	182.6	192.4	21.009	2.503	32.509	0.0547	0.005	0.0136	0.043	3.015	5.798	3.60	24.60
LICK-127-R-2003	4.46	81.8	-31.5	9.179	0.000	12.808	0.0285	0.004	0.0004	0.015	0.624	29.373	0.90	54.40
LOCK-103-R-2003	6.32	141.2	197.6	13.630	4.879	10.625	0.0652	0.042	0.0076	0.027	5.917	10.690	1.70	4.10
LOCK-104-R-2003	6.15	190.3	96.4	24.557	7.405	9.831	0.0281	0.019	0.0088	0.041	8.284	6.020	5.60	1.40
LOCK-108-R-2003	6.36	215.3	193.6	17.389	11.411	14.227	0.0570	0.011	0.0085	0.017	12.308	2.428	8.60	2.90
LOCK-110-R-2003	6.46	166.2	137.8	15.092	7.032	14.500	0.0519	0.029	0.0060	0.014	7.952	7.141	5.30	0.60
LOCK-118-R-2003	6.10	158.9	331.3	21.434	0.014	22.854	0.0546	0.025	0.0037	0.018	0.566	15.367	1.50	3.30
LOCK-126-R-2003	6.63	166.9	202.7	20.611	4.320	18.585	0.0185	0.001	0.0077	0.006	4.943	5.849	6.50	1.80
LOCK-128-R-2003	5.49	201.1	19.7	19.568	5.185	40.475	0.0114	0.001	0.0004	0.017	5.905	2.268	7.30	1.40

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
LICK-121-R-2003	50	50	TG	TG	12	13	3	6	75	0	0	100	87	20	25
LICK-125-R-2003	8	0	CP	CP	12	10	3	6	75	0	0	100	85	19	21
LICK-127-R-2003	20	20	CP	CP	8	7	3	6	75	0	0	100	60	19	24
LOCK-103-R-2003	48	50	CP	FR	2	2	2	6	75	0	0	100	95	20	19
LOCK-104-R-2003	10	35	CP	CP	7	7	6	3	75	11	30	100	85	11	16
LOCK-108-R-2003	10	50	CP	FR	5	4	6	7	45	11	30	100	90	16	24
LOCK-110-R-2003	50	20	LN	CP	6	5	3	6	75	0	0	100	92	9	22
LOCK-118-R-2003	50	50	FR	FR	3	3	2	6	75	0	0	100	96	16	26
LOCK-126-R-2003	50	50	FR	FR	15	15	14	16	40	15	41	20	85	13	68
LOCK-128-R-2003	50	50	FR	FR	9	8	8	10	36	11	39	100	85	16	44

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
LICK-121-R-2003	N	N	N	Y	NONE	NONE	NONE
LICK-125-R-2003	Y	N	N	Y	NONE	NONE	NONE
LICK-127-R-2003	N	N	N	Y	NONE	NONE	NONE
LOCK-103-R-2003	N	N	N	Y	NONE	NONE	EXTENSIVE
LOCK-104-R-2003	N	N	N	N	NONE	NONE	MODERATE
LOCK-108-R-2003	N	N	N	Y	NONE	NONE	MINOR
LOCK-110-R-2003	N	N	N	N	NONE	NONE	MODERATE
LOCK-118-R-2003	N	N	N	Y	NONE	NONE	NONE
LOCK-126-R-2003	N	N	N	N	MILD	MILD	MINOR
LOCK-128-R-2003	N	Y	N	N	MILD	MILD	MODERATE

Honga River/Lower Choptank/Little Choptank

Fish Species Present
AMERICAN EEL
BANDED SUNFISH
BLUEGILL
CHAIN PICKEREL
CREEK CHUBSUCKER
EASTERN MUDMINNOW
LEAST BROOK LAMPREY
MUMMICHOG
PIRATE PERCH
PUMPKINSEED
REDFIN PICKEREL
TESSELLATED DARTER

Exotic Plants Present
MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM
PHRAGMITES

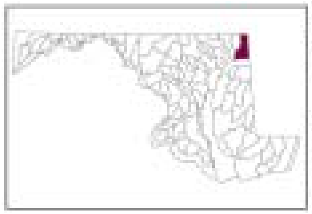
Benthic Taxa Present
AGABUS
AGARODES
ANAX
ANCHYTARSUS
BOYERIA
CAECIDOTEA
CERATOPOGON
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIRONOMINI
CHRYSOPS
COENAGRIONIDAE
COLLEMBOLA
CORDULEGASTER
CORYDALUS
CORYNONEURA
CRANGONYCTIDAE
CRANGONYX
CURA
DINEUTUS
DIPLECTRONA
DIPLOCLADIUS
DUGESIA
DYTISCIDAE
ENCHYTRAEIDAE
EURYLOPHELLA
HELICHUS
HELOCOMBUS
HEMERODROMIA
HETEROPLECTRON
HEXATOMA
HYDROBAENUS
HYDROBIUS
HYDROCHARA
HYDROPHILIDAE
HYDROPSYCHE
IRONOQUIA
LEPTOPHLEBIIDAE
LEUCTRA
LIBELLULIDAE
LIMNEPHILIDAE
LIMNOPHYES
LUMBRICULIDAE
LYPE
MENETUS
MICROCYLLOEPUS
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NECTOPSYCHE
NEMOURIDAE
NEOPHYLAX
NIGRONIA
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAKIEFFERIELLA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PHAENOPSECTRA
PHYSELLA
PLANORBELLA
POLYCENTROPODIDAE
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PROSTOMA
PSEUDOLIMNOPHILA
PSEUDOSUCCINEA
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
STAGNICOLA
STEGOPTERNA
STENONEMA
SYNURELLA
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
ZALUTSCHIA
ZAVRELIMYIA

Herpetofauna Present
BULLFROG
EASTERN BOX TURTLE
EASTERN GARTER SNAKE
FOWLER'S TOAD
GREEN FROG
GREEN TREEFROG
NORTHERN BLACK RACER
PICKEREL FROG
SOUTHERN LEOPARD FROG

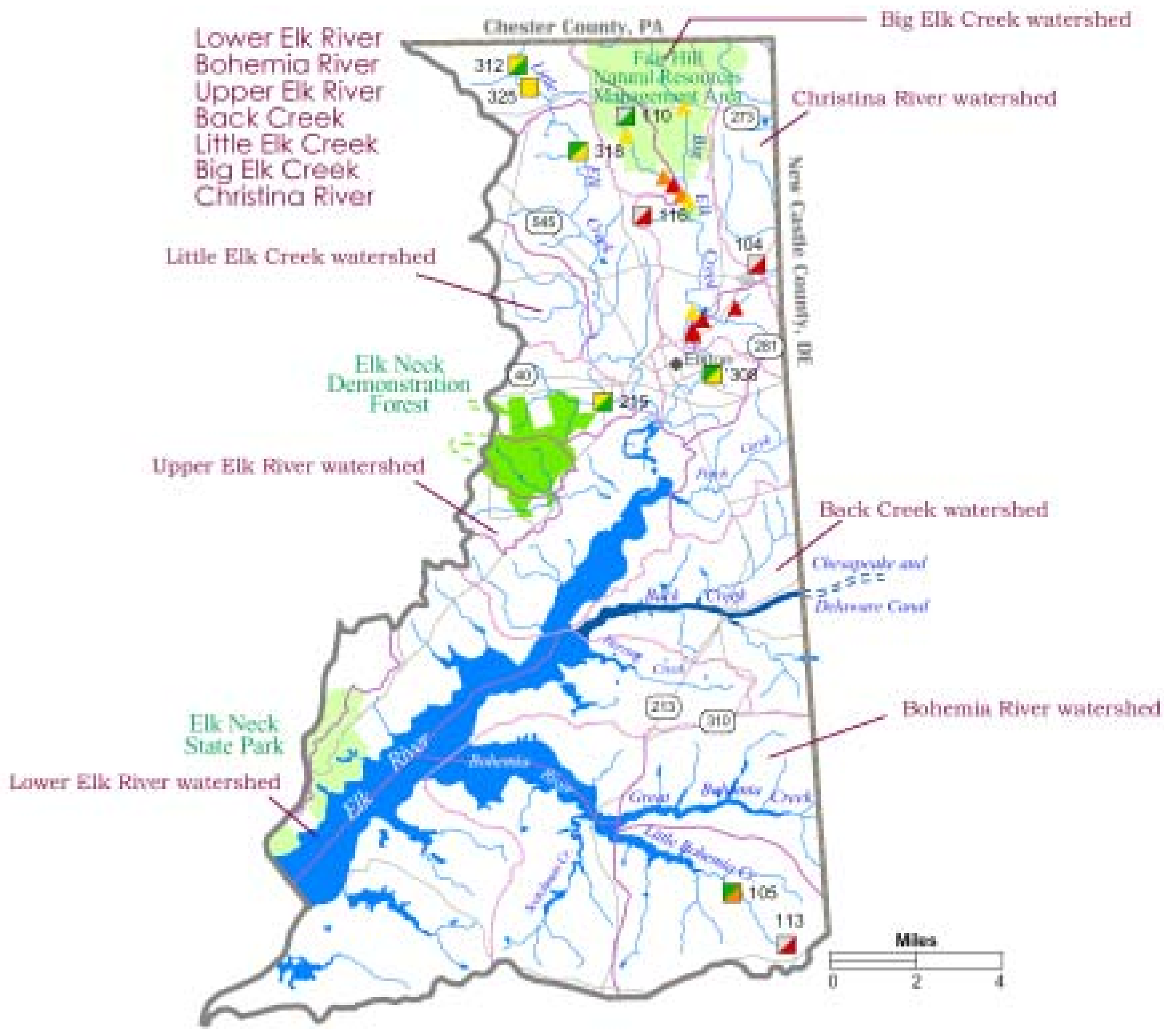
Honga River/Lower Choptank/Little Choptank

Stream Waders Data

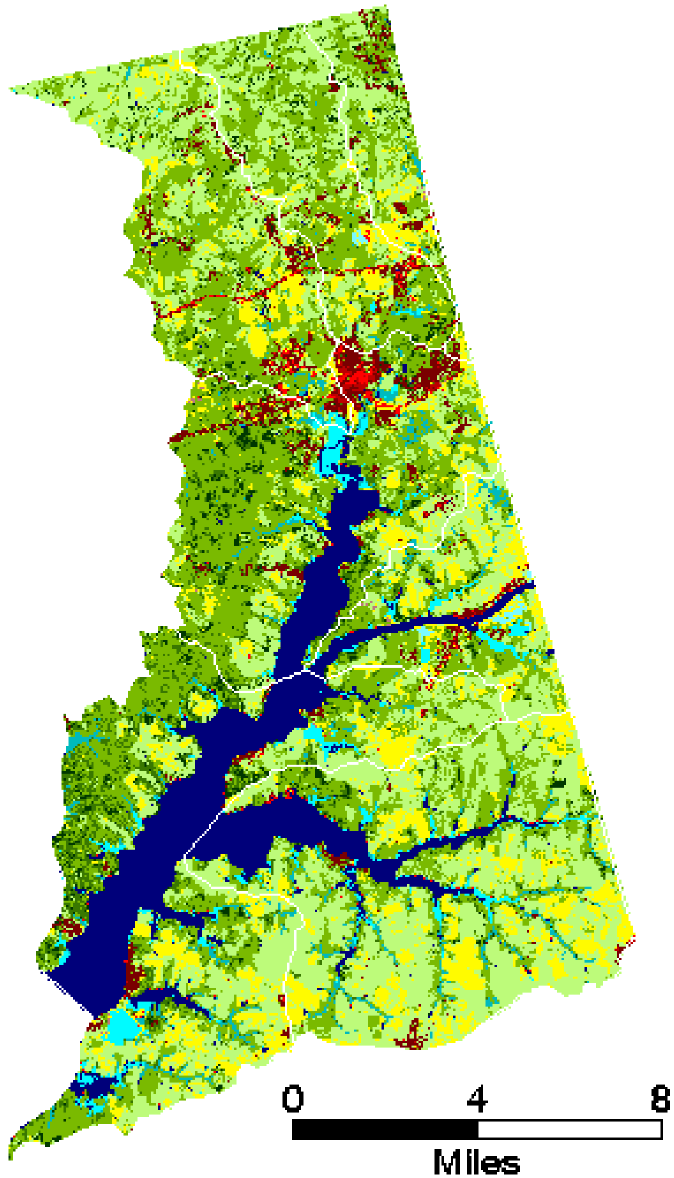
Site	8-digit Watershed	Stream Name	Benthic IBI
459-1-2003	Lower Choptank	Boilingbroke Cr.	1.29
459-2-2003	Lower Choptank	Boilingbroke Cr.	2.14
471-1-2003	Lower Choptank	Hunting Cr.	1.00
471-3-2003	Lower Choptank	Hunting Cr.	2.14
471-4-2003	Lower Choptank	Hunting Cr.	3.29
471-5-2003	Lower Choptank	Hunting Cr. UT	3.00
463-2-2003	Lower Choptank	Indian Cr. UT	1.86
462-1-2003	Lower Choptank	Peach Blossom Cr. UT	1.57
459-3-2003	Lower Choptank	Raccoon Cr.	3.29
471-2-2003	Lower Choptank	Upper Hunting Cr.	1.00
466-5-2003	Lower Choptank	Warwick R. UT	1.29
466-3-2003	Lower Choptank	Warwick R. UT	2.14
466-1-2003	Lower Choptank	Warwick R. UT	3.29
466-4-2003	Lower Choptank	Warwick R. UT	3.29
466-2-2003	Lower Choptank	Warwick R. UT	3.57



Lower Elk River/Bohemia River/
Upper Elk River/Back Creek/
Little Elk Creek/Big Elk Creek/
Christina River watersheds
MBSS 2003

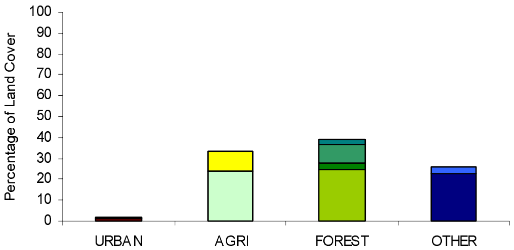


Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

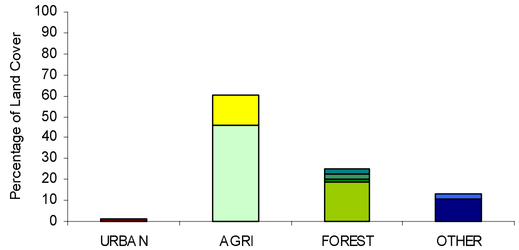


Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

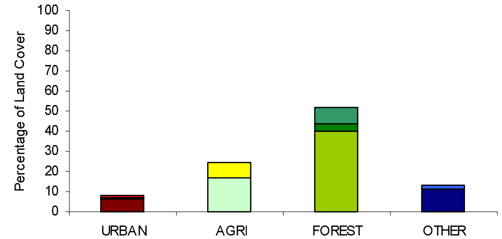
Lower Elk River



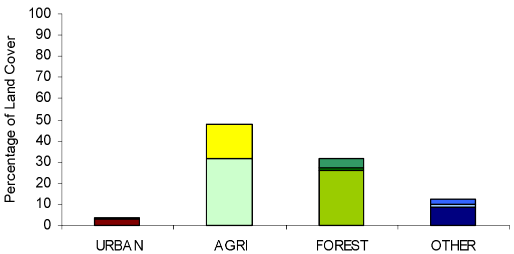
Bohemia River



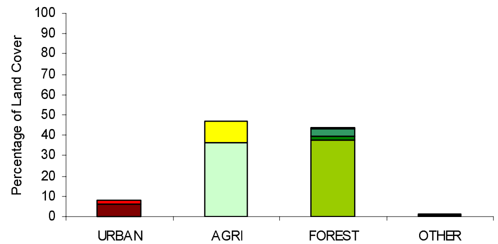
Upper Elk River



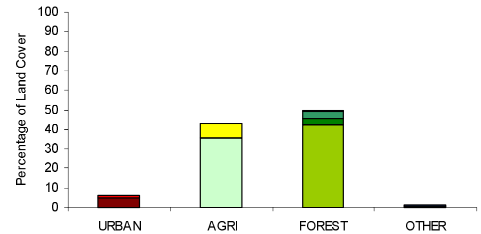
Back Creek



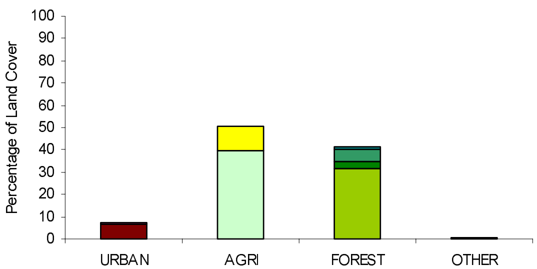
Little Elk Creek



Big Elk Creek



Christina River



Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
BELK-110-R-2003	GRAMIES RUN	021306060387	Big Elk Creek	ELK RIVER	Cecil	9-Apr-03	30-Jul-03	1	255
BELK-116-R-2003	BIG ELK CR UT1	021306060386	Big Elk Creek	ELK RIVER	Cecil	9-Apr-03	30-Jul-03	1	74
BOHE-105-R-2003	LITTLE BOHEMIA CR UT1	021306020365	Bohemia River	ELK RIVER	Cecil	14-Apr-03	29-Jul-03	1	1871
BOHE-113-R-2003	LITTLE BOHEMIA CR UT1	021306020365	Bohemia River	ELK RIVER	Cecil	8-Apr-03	29-Jul-03	1	157
CHRI-104-R-2003	PERSIMMON RUN	021306070381	Christina River	ELK RIVER	Cecil	9-Apr-03	6-Aug-03	1	184
LIEL-312-R-2003	LITTLE ELK CR	021306050384	Little Elk Creek	ELK RIVER	Cecil	14-Apr-03	5-Aug-03	3	9239
LIEL-318-R-2003	LITTLE ELK CR	021306050382	Little Elk Creek	ELK RIVER	Cecil	14-Apr-03	12-Aug-03	3	12507
LIEL-325-R-2003	LITTLE ELK CR	021306050384	Little Elk Creek	ELK RIVER	Cecil	14-Apr-03	31-Jul-03	3	10181
UELK-215-R-2003	MILL CR (ELK)	021306030371	Upper Elk River	ELK RIVER	Cecil	8-Apr-03	6-Aug-03	2	2741
UELK-308-R-2003	BIG ELK CR	021306030373	Upper Elk River	ELK RIVER	Cecil	8-Apr-03	19-Aug-03	3	37448

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
BELK-110-R-2003	NR	4.33	75.64	0	0
BELK-116-R-2003	NR	1.89	59.27	0	0
BOHE-105-R-2003	4.50	2.71	63.93	0	0
BOHE-113-R-2003	NR	1.57	68.27	0	0
CHRI-104-R-2003	NR	1.67	29.34	0	0
LIEL-312-R-2003	3.00	4.33	59.26	0	0
LIEL-318-R-2003	4.33	3.89	66.51	0	0
LIEL-325-R-2003	3.67	3.89	65.47	0	0
UELK-215-R-2003	3.50	4.14	54.62	0	0
UELK-308-R-2003	4.25	3.57	56.12	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
BELK-110-R-2003	1.05	53.89	45.07	0.00	0.48
BELK-116-R-2003	7.14	66.96	25.89	0.00	1.79
BOHE-105-R-2003	2.26	86.01	11.32	0.42	0.74
BOHE-113-R-2003	17.02	82.13	0.85	0.00	5.82
CHRI-104-R-2003	4.49	86.17	8.62	0.73	1.73
LIEL-312-R-2003	4.33	70.65	24.49	0.53	1.46
LIEL-318-R-2003	4.33	69.52	25.61	0.54	1.41
LIEL-325-R-2003	4.09	71.54	23.86	0.51	1.37
UELK-215-R-2003	10.00	7.63	81.26	1.11	3.14
UELK-308-R-2003	3.90	62.04	33.37	0.69	1.65
Overall PSU					

Summary of Watershed Condition

- Several sites in highly agricultural catchments
- Nitrogen and phosphorus elevated throughout
- Chloride high at some sites
- Turbidity extremely high at site CHRI-104
- Riffle/run quality 0 at two sites

Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (ueq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs)
BELK-110-R-2003	7.05	270.7	711.7	55.243	0.758	10.901	0.0312	0.007	0.0043	0.009	0.989	5.764	8.20	0.70
BELK-116-R-2003	6.88	107.9	390.3	12.541	0.477	8.650	0.2226	0.091	0.0068	0.128	1.392	14.466	7.00	3.50
BOHE-105-R-2003	7.31	187.6	715.6	17.052	3.684	15.806	0.1145	0.005	0.0333	0.099	3.871	3.340	6.70	18.80
BOHE-113-R-2003	7.48	266.1	1510.9	17.833	2.453	23.844	0.1123	0.030	0.0255	0.069	2.693	3.886	5.40	13.80
CHRI-104-R-2003	6.51	49.4	137.7	4.308	0.237	6.158	0.1447	0.009	0.0071	0.052	0.647	7.301	1.80	999.90
LIEL-312-R-2003	8.66	170.7	724.5	15.114	3.454	11.336	0.0293	0.009	0.0137	0.008	3.574	2.556	7.80	2.00
LIEL-318-R-2003	8.04	187.9	736.6	20.274	3.078	13.999	0.0280	0.006	0.0120	0.009	3.151	2.523	7.70	11.50
LIEL-325-R-2003	8.09	172.7	748.3	15.166	3.521	12.007	0.0284	0.008	0.0134	0.007	3.640	2.590	10.70	1.70
UELK-215-R-2003	6.41	135.9	113.7	27.046	0.330	12.742	0.0229	0.001	0.0022	0.028	0.510	5.026	6.70	9.90
UELK-308-R-2003	7.66	194.7	410.4	31.323	2.723	14.029	0.0190	0.001	0.0101	0.004	2.780	2.379	8.30	3.30

Physical Habitat Condition

Site	Riparian Buffer Width Left	Riparian Buffer Width Right	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	Embed- dedness	Shading	Trash Rating	Maximum Depth (cm)
BELK-110-R-2003	50	50	FR	FR	16	17	13	12	42	13	39	15	96	20	68
BELK-116-R-2003	50	7	OF	PA	10	10	5	7	43	7	32	30	95	14	39
BOHE-105-R-2003	40	50	CP	FR	14	13	13	13	43	16	45	100	20	20	68
BOHE-113-R-2003	50	50	TG	TG	7	6	7	11	75	0	0	100	90	17	50
CHRI-104-R-2003	20	50	PV	LN	2	1	1	1	15	0	0	100	95	11	15
LIEL-312-R-2003	0	0	HO	PA	16	14	14	15	57	17	22	55	10	16	103
LIEL-318-R-2003	30	50	PV	FR	18	17	13	16	35	17	75	40	65	16	96
LIEL-325-R-2003	0	0	PV	PA	17	18	15	16	30	16	55	15	15	18	107
UELK-215-R-2003	50	50	FR	LN	9	9	11	15	70	11	5	65	75	19	99
UELK-308-R-2003	50	50	FR	FR	11	13	17	15	62	16	20	40	80	13	118

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
BELK-110-R-2003	N	N	N	N	Moderate	Mild	Extensive
BELK-116-R-2003	N	N	N	N	Moderate	Moderate	Extensive
BOHE-105-R-2003	N	N	N	N	Moderate	Moderate	None
BOHE-113-R-2003	N	N	N	N	Moderate	Moderate	None
CHRI-104-R-2003	N	N	N	N	None	None	Minor
LIEL-312-R-2003	Y	N	N	Y	Moderate	Moderate	Minor
LIEL-318-R-2003	N	N	N	N	Severe	Mild	Extensive
LIEL-325-R-2003	Y	N	N	N	Severe	Moderate	Moderate
UELK-215-R-2003	N	N	N	N	Moderate	Moderate	Moderate
UELK-308-R-2003	N	N	N	Y	Moderate	Severe	Extensive

Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

Fish Species Present
ALEWIFE
AMERICAN EEL
BANDED KILLIFISH
BLACK CRAPPIE
BLACKNOSE DACE
BLUE RIDGE SCULPIN
BLUEBACK HERRING
BLUEGILL
BLUESPOTTED SUNFISH
BROWN BULLHEAD
COMMON SHINER
CREEK CHUB
CREEK CHUBSUCKER
CUTLIPS MINNOW
EASTERN MUDMINNOW
FATHEAD MINNOW
GOLDEN SHINER
GREEN SUNFISH
LARGEMOUTH BASS
LEAST BROOK LAMPREY
LONGNOSE DACE
MARGINED MADTOM
MOSQUITOFISH
MUMMICHOG
NORTHERN HOGSUCKER
PUMPKINSEED
REDBREAST SUNFISH
REDFIN PICKEREL
RIVER CHUB
ROSYFACE SHINER
ROSYSIDE DACE
SATINFIN SHINER
SEA LAMPREY
SMALLMOUTH BASS
SPOTFIN SHINER
SPOTTAIL SHINER
STRIPED BASS
SWALLOWTAIL SHINER
TESSELLATED DARTER
WHITE PERCH
WHITE SUCKER

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM
JAPANESE KNOTWEED

Benthic Taxa Present
AEDES
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
ANCYRONYX
ANTOCHA
ARGIA
BAETIDAE
BELOSTOMA
BEROSUS
BEZZIA
BOYERIA
CAECIDOTEA
CAENIS
CALOPTERYX
CERATOPOGONIDAE
CHAETOCLADIUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMINAE
CHLOROPERLIDAE
CHRYSOPS
CLINOCERA
COENAGRIONIDAE
CONCHAPELOPIA
COPELATUS
CORIXIDAE
CORYDALUS
CORYNONEURA
CRICOTOPUS
CURCULIONIDAE
DIAMESA
DICROTENDIPES
DINEUTUS
DIPLECTRONA
DRUNELLA
DUBIRAPHIA
DUGESIA
ECCOPTURA
ECTOPRIA
ELMIDAE
ENALLAGMA
ENCHYTRAEIDAE
EPHEMERELLA
EPHEMERELLIDAE
EPHEMEROPTERA
EURYLOPHELLA
GAMMARUS
GOMPHIDAE
GONIOBASIS
GYRINUS
HELICOPSYCHE
HELISOMA
HEPTAGENIIDAE
HEXATOMA
HYDROBAENUS
HYDROCHUS
HYDROPSYCHE
HYDROPSYCHIDAE
HYDROPTILA
IRONOQUIA
ISONYCHIA
LABRUNDINIA
LEPIDOSTOMA
LEPTOPHLEBIIDAE
LEUCTRA
LIMNEPHILIDAE
LIMNODRILUS
LIMNOPHYES
LUMBRICULIDAE
LYMNAEIDAE
MACRONYCHUS
MICROPSECTRA
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NEOPHYLAX
NIGRONIA
NOCTUIDAE
OECETIS
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PELTODYTES
PHAENOPSECTRA
PHYSELLA
PISIDIUM
POLYCENTROPUS
POLYPEDILUM
PROBEZZIA
PROMORESIA
PROSIMULIUM
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PSILOTRETA
PTILOSTOMIS
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SCIOMYZIDAE
SERRATELLA
SIALIS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
SPIROSPERMA
STAGNICOLA
STEMPELLINELLA
STENELMIS
STENONEMA
STRATIOMYS
STYLOGOMPHUS
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIAENODES
TRICHOPTERA
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present
AMERICAN TOAD
BULLFROG
COMMON MUSK TURTLE
COMMON SNAPPING TURTLE
FOWLER'S TOAD
GREEN FROG
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
WOOD FROG

Lower Elk River/Bohemia River/Upper Elk River/Back Creek/Little Elk Creek/Big Elk Creek/Christina River

Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
386-5-2003	Big Elk Creek	Big Elk Cr.	3.00
386-3-2003	Big Elk Creek	Big Elk Cr.	3.29
386-2-2003	Big Elk Creek	Big Elk Cr.	3.86
387-4-2003	Big Elk Creek	Gramie's Run	1.29
387-3-2003	Big Elk Creek	Gramie's Run	2.14
387-5-2003	Big Elk Creek	Gramie's Run	2.43
387-1-2003	Big Elk Creek	Gramie's Run	3.86
385-3-2003	Big Elk Creek	Upper Elk Cr. UT	1.00
385-1-2003	Big Elk Creek	Upper Elk Cr. UT	1.29
385-4-2003	Big Elk Creek	Upper Elk Cr. UT	1.57
385-2-2003	Big Elk Creek	Upper Elk Cr. UT	1.86

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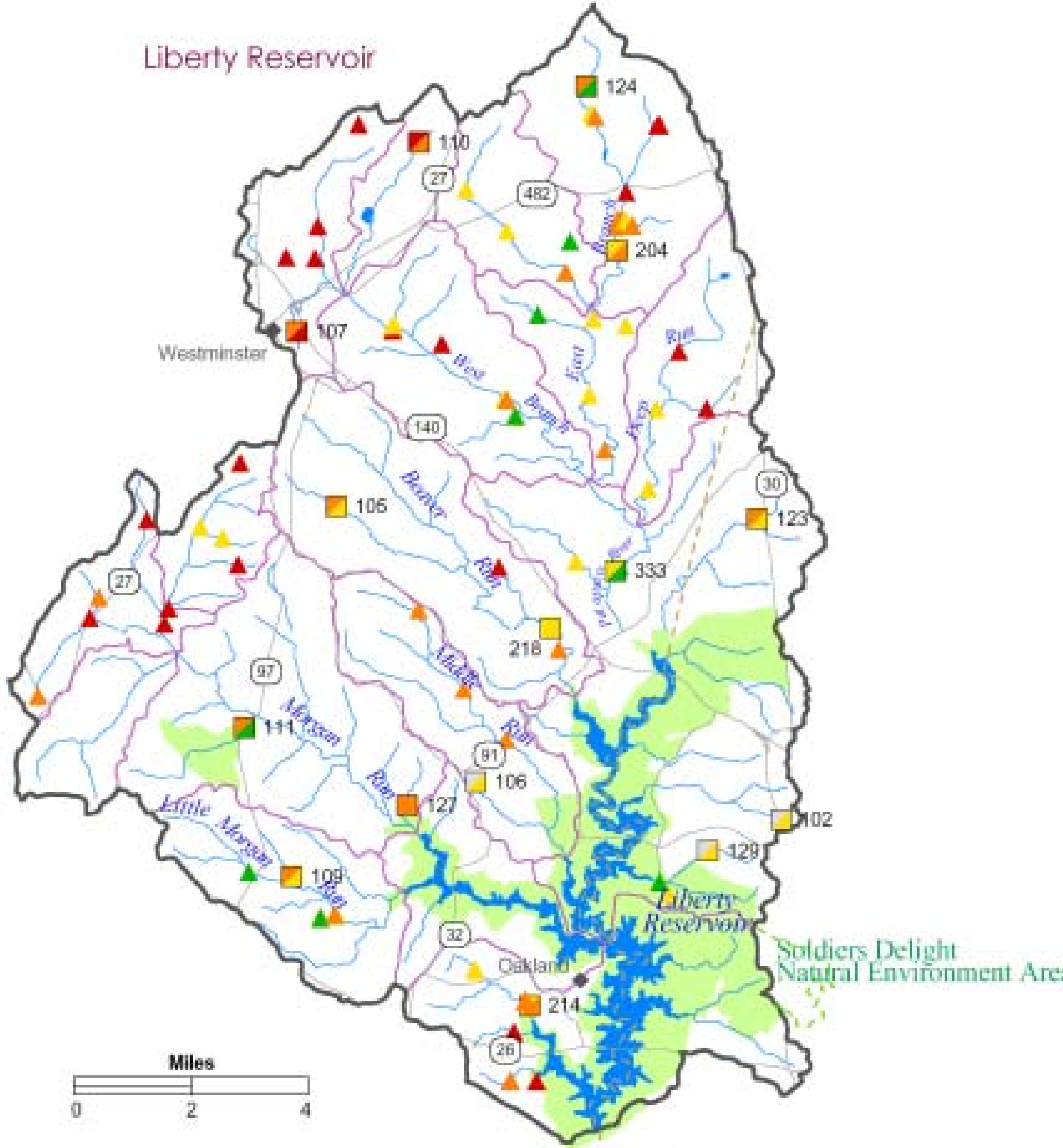
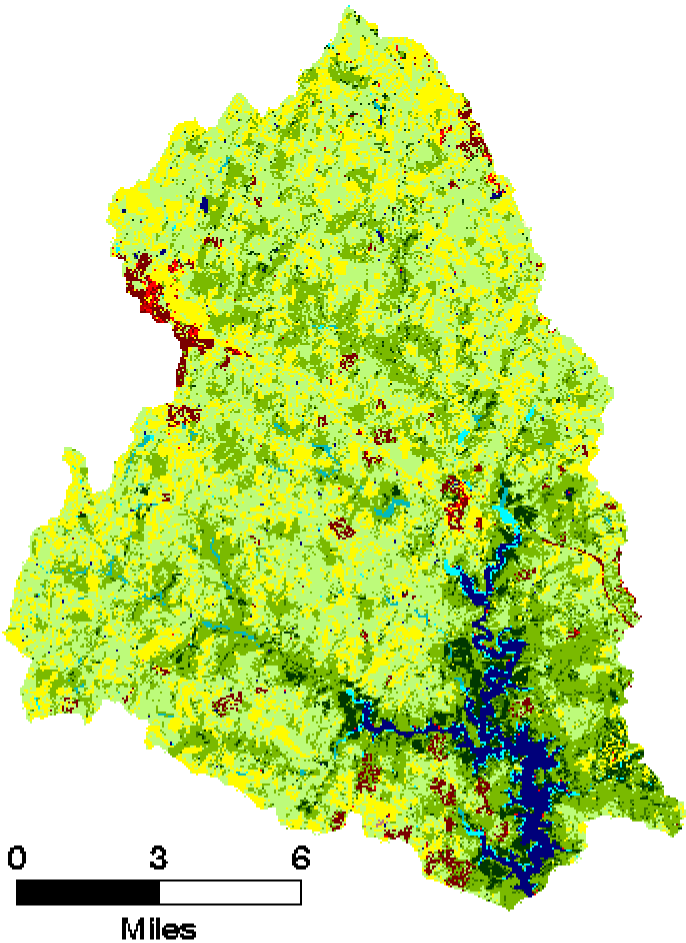
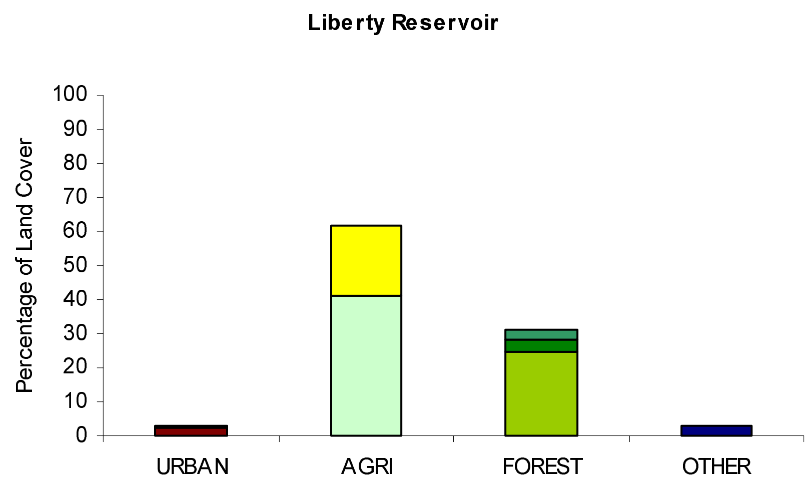
Liberty Reservoir watershed
MBSS 2003



Liberty Reservoir





Liberty Reservoir

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
LIBE-102-R-2003	NORRIS RUN UT1	021309071048	Liberty Reservoir	PATAPSCO RIVER	Baltimore	6-Mar-03	12-Jun-03	1	71
LIBE-105-R-2003	MIDDLE RUN	021309071057	Liberty Reservoir	PATAPSCO RIVER	Carroll	4-Mar-03	23-Jun-03	1	730
LIBE-106-R-2003	PRUGH BR	021309071056	Liberty Reservoir	PATAPSCO RIVER	Carroll	5-Mar-03	12-Jun-03	1	89
LIBE-107-R-2003	LONGWELL BR	021309071062	Liberty Reservoir	PATAPSCO RIVER	Carroll	4-Mar-03	3-Jun-03	1	353
LIBE-109-R-2003	LITTLE MORGAN RUN UT4	021309071049	Liberty Reservoir	PATAPSCO RIVER	Carroll	5-Mar-03	18-Jun-03	1	429
LIBE-110-R-2003	CRANBERRY BR	021309071061	Liberty Reservoir	PATAPSCO RIVER	Carroll	4-Mar-03	23-Jun-03	1	365
LIBE-111-R-2003	MORGAN RUN UT3	021309071050	Liberty Reservoir	PATAPSCO RIVER	Carroll	5-Mar-03	18-Jun-03	1	1428
LIBE-123-R-2003	NORTH BR PATAPSCO R UT1	021309071048	Liberty Reservoir	PATAPSCO RIVER	Baltimore	6-Mar-03	12-Jun-03	1	551
LIBE-124-R-2003	CASCADE LAKE UT1	021309071059	Liberty Reservoir	PATAPSCO RIVER	Carroll	10-Mar-03	9-Jul-03	1	586
LIBE-127-R-2003	MORGAN RUN UT4	021309071050	Liberty Reservoir	PATAPSCO RIVER	Carroll	5-Mar-03	18-Jun-03	1	452
LIBE-129-R-2003	TIMBER RUN	021309071048	Liberty Reservoir	PATAPSCO RIVER	Baltimore	6-Mar-03	9-Jul-03	1	329
LIBE-204-R-2003	EAST BR PATAPSCO	021309071059	Liberty Reservoir	PATAPSCO RIVER	Carroll	4-Mar-03	25-Jun-03	2	5745
LIBE-214-R-2003	LIBERTY RESERVOIR UT1	021309071046	Liberty Reservoir	PATAPSCO RIVER	Carroll	5-Mar-03	23-Jun-03	2	1580
LIBE-218-R-2003	BEAVER RUN	021309071057	Liberty Reservoir	PATAPSCO RIVER	Carroll	6-Mar-03	4-Aug-03	2	7962
LIBE-333-R-2003	NORTH BR PATAPSCO R	021309071048	Liberty Reservoir	PATAPSCO RIVER	Carroll	10-Mar-03	4-Aug-03	3	33754

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
LIBE-102-R-2003	NR	3.67	40.8	0	0
LIBE-105-R-2003	2.11	3.67	73.77	0	0
LIBE-106-R-2003	NR	3.22	68.88	0	0
LIBE-107-R-2003	2.11	1.89	59.14	0	0
LIBE-109-R-2003	2.33	3.44	77.13	0	0
LIBE-110-R-2003	1.67	2.78	58.99	0	0
LIBE-111-R-2003	2.11	4.11	65.03	0	0
LIBE-123-R-2003	2.11	3.22	56.23	0	0
LIBE-124-R-2003	2.56	4.56	75.71	0	0
LIBE-127-R-2003	2.78	2.56	84.07	0	0
LIBE-129-R-2003	NR	3.44	86.61	1	0
LIBE-204-R-2003	3.89	2.78	80.53	0	0
LIBE-214-R-2003	3.22	2.78	82.9	0	0
LIBE-218-R-2003	3.00	3.67	67.87	0	0
LIBE-333-R-2003	3.44	4.11	76.58	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
LIBE-102-R-2003	20.81	48.76	30.43	0.00	10.95
LIBE-105-R-2003	10.31	68.79	20.84	0.06	3.10
LIBE-106-R-2003	4.03	85.39	8.82	1.76	1.26
LIBE-107-R-2003	43.70	54.16	2.14	0.00	16.15
LIBE-109-R-2003	8.84	69.84	21.01	0.31	2.21
LIBE-110-R-2003	0.00	89.41	10.28	0.31	0.00
LIBE-111-R-2003	1.57	62.61	35.66	0.16	0.39
LIBE-123-R-2003	1.01	83.35	14.99	0.65	0.35
LIBE-124-R-2003	0.38	91.74	7.54	0.34	0.17
LIBE-127-R-2003	0.15	83.93	15.87	0.05	0.11
LIBE-129-R-2003	0.07	32.97	66.96	0.00	0.02
LIBE-204-R-2003	3.21	84.07	12.38	0.35	1.22
LIBE-214-R-2003	8.99	62.12	27.87	1.01	2.43
LIBE-218-R-2003	5.05	68.71	25.99	0.24	1.52
LIBE-333-R-2003	3.12	73.59	22.73	0.56	1.22
Overall PSU					

Liberty Reservoir

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
LIBE-102-R-2003	6.88	478.8	607.7	119.891	0.838	10.674	0.0849	0.014	0.0127	0.112	1.177	4.409	7.80	4.40
LIBE-105-R-2003	7.07	292.8	283.4	68.793	4.921	7.009	0.0090	0.001	0.0029	0.007	5.205	1.025	8.90	2.70
LIBE-106-R-2003	6.67	138.1	370.9	22.083	1.592	7.391	0.0425	0.004	0.0114	0.040	1.808	2.186	7.70	7.60
LIBE-107-R-2003	8.05	1304.2	2120.2	337.823	5.304	15.096	0.0166	0.001	0.1510	0.039	6.004	1.290	9.20	1.00
LIBE-109-R-2003	7.28	272.7	337.3	62.183	4.152	6.229	0.0144	0.006	0.0004	0.005	4.229	1.040	11.00	1.50
LIBE-110-R-2003	7.34	223.1	978.9	24.418	4.418	8.973	0.1671	0.079	0.0434	0.194	5.172	4.930	7.10	4.60
LIBE-111-R-2003	7.25	168.2	323.8	31.967	3.138	5.901	0.0147	0.005	0.0019	0.004	3.246	0.841	8.60	1.50
LIBE-123-R-2003	6.85	124.0	390.8	16.767	1.855	6.052	0.2887	0.146	0.0117	0.632	3.055	3.583	8.40	21.70
LIBE-124-R-2003	7.14	167.5	274.4	23.728	4.852	7.787	0.0100	0.005	0.0024	0.006	5.095	1.122	8.60	4.30
LIBE-127-R-2003	7.31	174.9	343.2	33.038	3.016	5.861	0.0217	0.012	0.0023	0.006	3.110	1.568	9.40	1.80
LIBE-129-R-2003	6.82	121.4	179.4	23.008	1.367	6.412	0.0488	0.001	0.0015	0.017	1.507	2.762	8.70	4.00
LIBE-204-R-2003	7.48	224.7	508.3	35.825	4.954	7.613	0.0414	0.020	0.0072	0.043	5.275	1.808	8.60	8.70
LIBE-214-R-2003	7.37	311.3	537.7	73.122	2.069	7.376	0.0399	0.004	0.0049	0.009	2.218	1.941	9.40	4.80
LIBE-218-R-2003	7.05	153.2	388.8	24.694	2.117	6.363	0.1521	0.020	0.0063	0.119	2.492	4.206	9.00	3.90
LIBE-333-R-2003	7.39	189.4	479.6	27.571	3.356	8.090	0.0427	0.027	0.0047	0.062	3.561	1.860	8.30	6.20

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
LIBE-102-R-2003	20	50	PV	FR	7	6	6	7	45	6	30	60	80	14	32
LIBE-105-R-2003	45	50	CP	FR	14	17	8	7	10	14	75	15	85	17	33
LIBE-106-R-2003	50	50	FR	FR	10	14	7	6	15	10	75	20	90	13	17
LIBE-107-R-2003	38	15	PK	PV	13	11	12	14	48	13	38	35	85	5	58
LIBE-109-R-2003	50	50	FR	FR	13	17	8	6	16	15	75	30	90	17	26
LIBE-110-R-2003	50	50	LN	LN	8	12	6	6	16	7	68	35	98	16	36
LIBE-111-R-2003	12	5	PV	PA	11	16	7	5	10	15	75	35	92	14	29
LIBE-123-R-2003	45	40	CP	LN	9	11	7	8	15	11	65	40	95	16	39
LIBE-124-R-2003	50	50	FR	FR	14	18	9	8	22	16	66	10	93	19	37
LIBE-127-R-2003	50	50	FR	FR	17	18	10	10	60	16	55	15	95	16	48
LIBE-129-R-2003	50	50	FR	FR	16	16	10	10	31	14	48	20	95	18	34
LIBE-204-R-2003	5	5	PA	PA	18	18	17	15	30	18	50	33	70	17	58
LIBE-214-R-2003	50	50	FR	FR	17	18	16	16	30	16	60	28	92	13	87
LIBE-218-R-2003	50	50	OF	OF	15	16	8	8	37	15	75	27	30	15	47
LIBE-333-R-2003	50	50	LN	FR	15	15	16	14	15	16	75	35	86	12	89

Liberty Reservoir

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
LIBE-102-R-2003	Y	N	N	N	Moderate	Moderate	Moderate
LIBE-105-R-2003	N	N	N	N	Severe	Moderate	Minor
LIBE-106-R-2003	N	N	N	N	Mild	Moderate	Moderate
LIBE-107-R-2003	Y	N	N	Y	Mild	Mild	Minor
LIBE-109-R-2003	N	N	N	N	Mild	Mild	Minor
LIBE-110-R-2003	N	N	N	N	Mild	Mild	Moderate
LIBE-111-R-2003	Y	N	N	N	Mild	Mild	None
LIBE-123-R-2003	N	N	N	N	Moderate	Moderate	Minor
LIBE-124-R-2003	N	N	N	N	Moderate	Moderate	Minor
LIBE-127-R-2003	N	N	N	N	Mild	Mild	Moderate
LIBE-129-R-2003	N	N	N	N	Mild	Moderate	Moderate
LIBE-204-R-2003	Y	N	N	N	Moderate	Mild	Minor
LIBE-214-R-2003	N	N	N	N	Moderate	Moderate	Moderate
LIBE-218-R-2003	N	N	N	N	Moderate	Mild	Minor
LIBE-333-R-2003	Y	N	N	Y	Mild	Mild	Moderate

Summary of Watershed Condition

- One site in a highly urban watershed, six in highly agricultural watersheds
- Nitrogen and phosphorus elevated throughout
- Chloride elevated at many sites
- Physical habitat parameters generally good
- Some channelization and buffer breaks

Liberty Reservoir

Fish Species Present

BLACKNOSE DACE
BLUE RIDGE SCULPIN
BLUEGILL
BLUNTNOSE MINNOW
BROOK TROUT
CENTRAL STONEROLLER
COMMON SHINER
CREEK CHUB
CUTLIPS MINNOW
GREEN SUNFISH
LARGEMOUTH BASS
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
PUMPKINSEED
REDBREAST SUNFISH
RIVER CHUB
ROSYFACE SHINER
ROSYSIDE DACE
SMALLMOUTH BASS
SPOTFIN SHINER
SPOTTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present

MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM
PHRAGMITES

Benthic Taxa Present

ACRONEURIA
ACRONEURIA
AESHNIDAE
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
ANCYLIDAE
ANTOCHA
BAETIDAE
BITTACOMORPHA
BOYERIA
BRILLIA
CAPNIIDAE
CERATOPOGON
CHAOBORUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMIDAE
CHIRONOMINAE
CHIRONOMUS
CHLOROPERLIDAE
CHRYSOPS
CLINOCERA
CONCHAPELOPIA
CORDULEGASTER
CORIXIDAE
CORYDALIDAE
CORYDALUS
CORYNONEURA
CRANGONYX
CRICOTOPUS
CRICOTOPUS/ORTHOCLADIUS
CRYPTOCHIRONOMUS
CULICOIDES
DIAMESA
DIAMESINAE
DICRANOTA
DIPLECTRONA
DOLICHOPODIDAE
DOLOPHILODES
ECCOPTURA
ENCHYTRAEIDAE
EPEORUS
EPHEMERA
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
EURYLOPHELLA
GAMMARUS
GLOSSOSOMA
GOMPHIDAE
HELENIELLA
HEXATOMA
HOMOPLECTRA
HYDROBAENUS
HYDROPORUS
HYDROPSYCHE
ISONYCHIA
LEPIDOSTOMA
LEPTOPHLEBIIDAE
LIMNEPHILIDAE
LIMNODRILUS
LUMBRICULIDAE
LYPE
MALIREKUS
MEROPELOPIA
MICROPSECTRA
MICROTENDIPES
MYSTACIDES
NAIDIDAE
NATARSIA
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OSTROCERCA
OULIMNIUS
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PELTOPERLIDAE
PERLIDAE
PERLODIDAE
PHAENOPSECTRA
PHASGANOPHORA
PHYSELLA
PLANARIIDAE
PLECOPTERA
POLYCENTROPUS
POLYPEDILUM
PROBEZZIA
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PSILOTRETA
PSYCHOMYIA
PTERONARCYS
PYCNOPSYCHE
RHEOTANYTARSUS
RHYACOPHILA
SERRATELLA
SIALIS
SIMULIUM
SPHAERIIDAE
STEGOPTERNA
STENACRON
STENELMIS
STENONEMA
STICTOCHIRONOMUS
STROPHOPTERYX
SWELTSA
SYMPOTTHASTIA
TABANIDAE
TABANUS
TAENIOPTERYX
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present

AMERICAN TOAD
BLACK RAT SNAKE
COMMON SNAPPING TURTLE
EASTERN BOX TURTLE
NORTHERN DUSKY SALAMANDER
NORTHERN RINGNECK SNAKE
NORTHERN SLIMY SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
RED SALAMANDER
REDBACK SALAMANDER
WOOD FROG

Liberty Reservoir

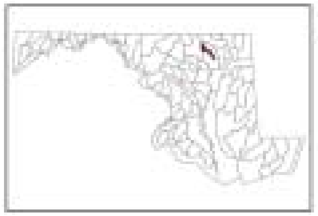
Stream Waders Data

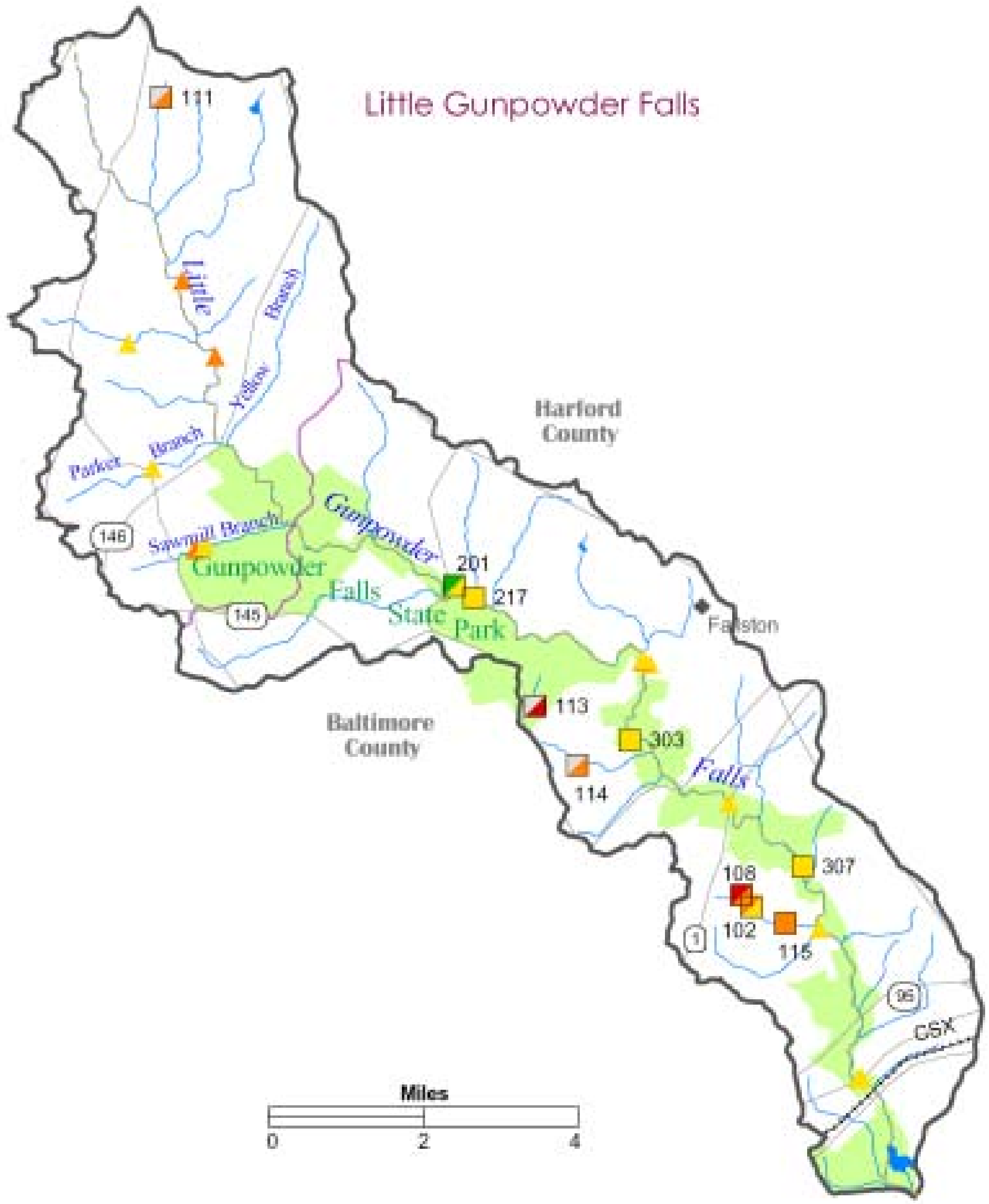
Site	8-digit Watershed	Stream Name	Benthic IBI
1058-4-2003	Liberty Reservoir	Aspen Run	1.00
1060-1-2003	Liberty Reservoir	Aspen Run	2.43
1060-4-2003	Liberty Reservoir	Aspen Run	3.29
1060-2-2003	Liberty Reservoir	Aspen Run	3.57
1057-31-2003	Liberty Reservoir	Beaver Run	1.29
1057-30-2003	Liberty Reservoir	Beaver Run	2.71
1058-2-2003	Liberty Reservoir	Deep Run	1.57
1058-1-2003	Liberty Reservoir	Deep Run	3.00
1058-3-2003	Liberty Reservoir	Deep Run	3.00
1052-5-2003	Liberty Reservoir	East Br. Patapsco R.	2.71
1052-2-2003	Liberty Reservoir	East Br. Patapsco R.	3.57
1052-4-2003	Liberty Reservoir	East Br. Patapsco R.	3.57
1052-1-2003	Liberty Reservoir	East Br. Patapsco UT	3.57
1052-3-2003	Liberty Reservoir	East Br. Patapsco UT	4.71
1059-2-2003	Liberty Reservoir	East Branch	1.57
1059-1-2003	Liberty Reservoir	East Branch	1.86
1059-4-2003	Liberty Reservoir	East Branch	2.71
1059-5-2003	Liberty Reservoir	East Branch UT	3.00
1059-3-2003	Liberty Reservoir	Indian Run	2.71
1059-6-2003	Liberty Reservoir	Indian Run	2.71
1059-93-2003	Liberty Reservoir	Indian Run	3.86
1046-5-2003	Liberty Reservoir	Liberty Reservior UT	1.29
1046-93-2003	Liberty Reservoir	Liberty Reservior UT	1.57
1046-92-2003	Liberty Reservoir	Liberty Reservior UT	1.86
1046-95-2003	Liberty Reservoir	Liberty Reservior UT	1.86
1046-2-2003	Liberty Reservoir	Liberty Reservior UT	2.14
1046-3-2003	Liberty Reservoir	Liberty Reservior UT	2.14
1046-94-2003	Liberty Reservoir	Liberty Reservior UT	2.43
1046-4-2003	Liberty Reservoir	Liberty Reservior UT	2.71
1046-1-2003	Liberty Reservoir	Liberty Reservior UT	3.00
1046-91-2003	Liberty Reservoir	Liberty Reservior UT	3.29
1055-5-2003	Liberty Reservoir	Little Morgan Run	1.57
1055-1-2003	Liberty Reservoir	Little Morgan Run	1.86
1049-91-2003	Liberty Reservoir	Little Morgan Run	2.43
1049-1-2003	Liberty Reservoir	Little Morgan Run	3.00
1055-4-2003	Liberty Reservoir	Little Morgan Run	3.29
1049-3-2003	Liberty Reservoir	Little Morgan Run	4.43
1055-2-2003	Liberty Reservoir	Little Morgan Run UT	1.00
1055-3-2003	Liberty Reservoir	Little Morgan Run UT	3.57
1049-92-2003	Liberty Reservoir	Little Morgan Run UT	3.86
1049-2-2003	Liberty Reservoir	Little Morgan Run UT	4.43
1056-20-2003	Liberty Reservoir	Middle Run	2.14
1056-21-2003	Liberty Reservoir	Middle Run	2.43
1056-11-2003	Liberty Reservoir	Middle Run	2.71
1054-4-2003	Liberty Reservoir	Morgan Run	1.86
1054-5-2003	Liberty Reservoir	Morgan Run UT	1.29
1054-2-2003	Liberty Reservoir	Morgan Run UT	1.86
1054-3-2003	Liberty Reservoir	Morgan Run UT	2.14
1054-1-2003	Liberty Reservoir	Morgan Run UT	2.43

Liberty Reservoir

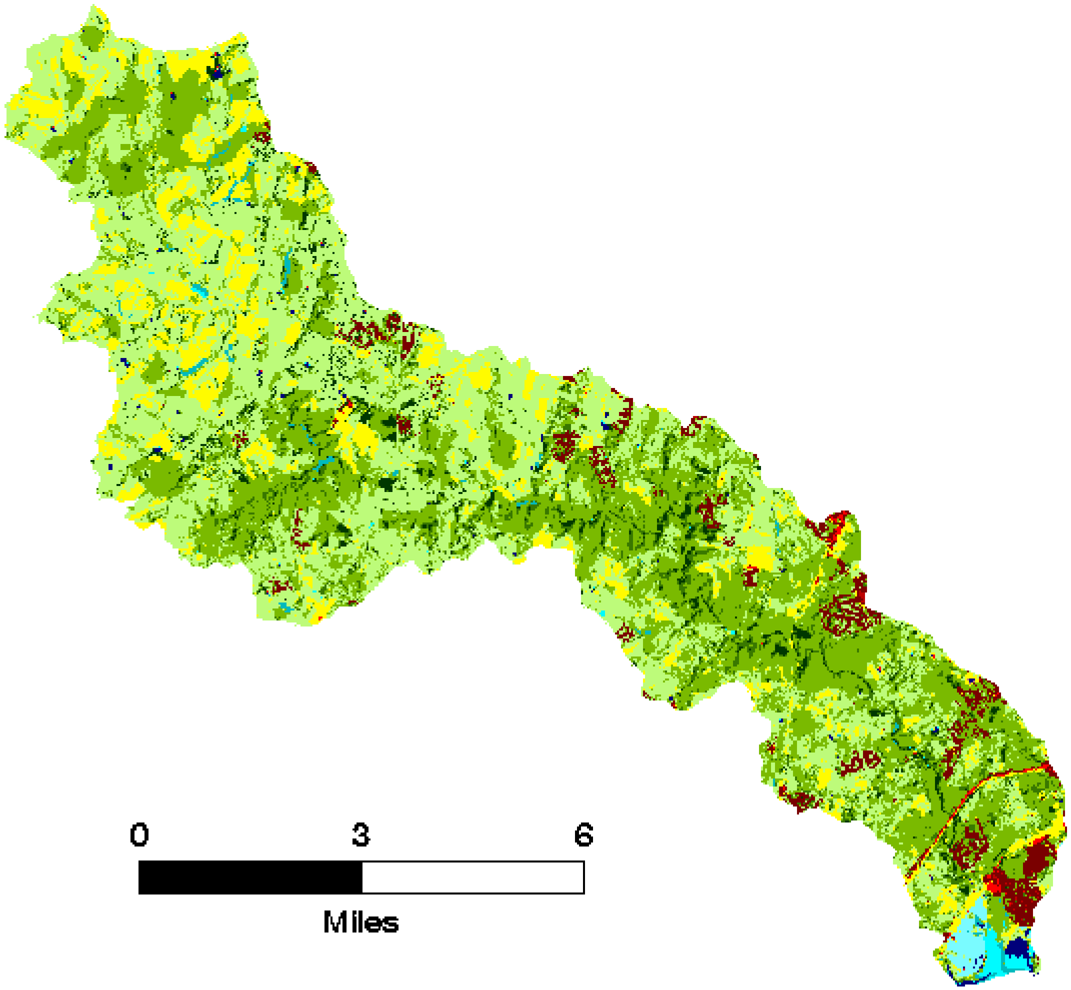
Site	8-digit Watershed	Stream Name	Benthic IBI
1059-91-2003	Liberty Reservoir	Patapsco R.- East Br.	1.29
1059-94-2003	Liberty Reservoir	Patapsco R.- East Br.	2.43
1059-95-2003	Liberty Reservoir	Patapsco R.- East Br. UT	2.71
1048-1-2003	Liberty Reservoir	Patapsco R. UT	3.29
1051-94-2003	Liberty Reservoir	Patapsco R.- West Br.	2.43
1051-95-2003	Liberty Reservoir	Patapsco R.- West Br. UT	3.86
1051-92-2003	Liberty Reservoir	Patapsco River- West Br.	3.86
1051-91-2003	Liberty Reservoir	Patapsco River- West Br. UT	4.14
1051-2-2003	Liberty Reservoir	Patapsco- West Br.	2.71
1048-4-2003	Liberty Reservoir	Roaring Run	3.29
1048-2-2003	Liberty Reservoir	Timber Run/Cooks Br.	4.71
1062-5-2003	Liberty Reservoir	West Br.	1.29
1051-4-2003	Liberty Reservoir	West Br.	1.86
1062-6-2003	Liberty Reservoir	West Br. UT	1.29
1062-7-2003	Liberty Reservoir	West Br. UT	1.57
1062-40-2003	Liberty Reservoir	West Br. UT	1.57
1051-3-2003	Liberty Reservoir	West Br. UT	1.86
1051-5-2003	Liberty Reservoir	West Br. UT	3.29
1051-1-2003	Liberty Reservoir	West Br. UT	3.86
1060-3-2003	Liberty Reservoir	White Dale Run	4.71

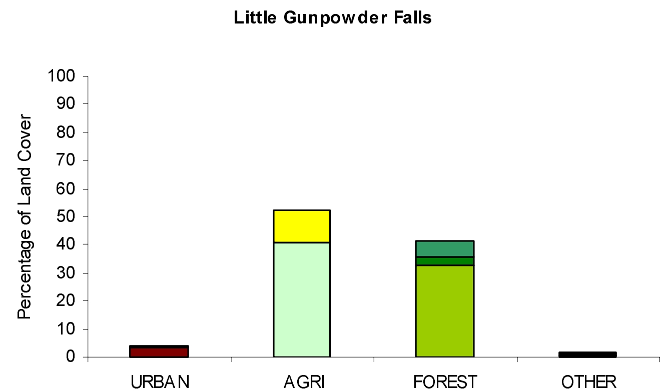
Little Gunpowder Falls watershed
MBSS 2003





Little Gunpowder Falls





Little Gunpowder Falls

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
LIGU-102-R-2003	LITTLE GUNPOWDER FALLS UT6	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore	12-Mar-03	9-Jun-03	1	482
LIGU-108-R-2003	LITTLE GUNPOWDER FALLS UT6	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore	12-Mar-03	5-Jun-03	1	329
LIGU-111-R-2003	LITTLE GUNPOWDER FALLS UT4	021308040299	Little Gunpowder Falls	GUNPOWDER RIVER	Harford	13-Mar-03	9-Jun-03	1	192
LIGU-113-R-2003	LITTLE GUNPOWDER FALLS UT5	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore	13-Mar-03	10-Jun-03	1	63
LIGU-114-R-2003	DICK BR	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore	12-Mar-03	5-Jun-03	1	211
LIGU-115-R-2003	LITTLE GUNPOWDER FALLS UT6	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore	12-Mar-03	9-Jun-03	1	721
LIGU-201-R-2003	LITTLE GUNPOWDER FALLS	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore, Harford	13-Mar-03	31-Jul-03	2	19809
LIGU-217-R-2003	LITTLE GUNPOWDER FALLS	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore, Harford	13-Mar-03	21-Jul-03	2	20693
LIGU-303-R-2003	LITTLE GUNPOWDER FALLS	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore, Harford	13-Mar-03	31-Jul-03	3	25728
LIGU-307-R-2003	LITTLE GUNPOWDER FALLS	021308040298	Little Gunpowder Falls	GUNPOWDER RIVER	Baltimore, Harford	12-Mar-03	21-Jul-03	3	29973

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
LIGU-102-R-2003	2.56	3.67	77.9	0	0
LIGU-108-R-2003	1.67	2.78	80.8	0	0
LIGU-111-R-2003	NS	2.33	NS	NS	NS
LIGU-113-R-2003	NR	1.44	45.47	0	0
LIGU-114-R-2003	NR	2.56	70.94	0	0
LIGU-115-R-2003	2.78	2.56	79.32	0	0
LIGU-201-R-2003	4.33	3.22	60.97	0	0
LIGU-217-R-2003	3.22	3.44	70.46	0	0
LIGU-303-R-2003	3.44	3.67	83.87	0	0
LIGU-307-R-2003	3.22	3.44	79.81	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
LIGU-102-R-2003	0.09	57.57	41.97	0.37	0.05
LIGU-108-R-2003	0.14	48.95	50.44	0.47	0.07
LIGU-111-R-2003	0.00	82.77	16.88	0.35	0.00
LIGU-113-R-2003	0.00	75.27	22.61	2.12	0.00
LIGU-114-R-2003	8.88	73.47	15.86	1.80	2.22
LIGU-115-R-2003	0.96	60.43	38.06	0.56	0.25
LIGU-201-R-2003	1.13	64.68	33.74	0.45	0.31
LIGU-217-R-2003	1.09	65.22	33.25	0.44	0.29
LIGU-303-R-2003	1.69	60.52	37.37	0.42	0.44
LIGU-307-R-2003	2.41	57.07	40.12	0.40	0.70
Overall PSU					

Summary of Watershed Condition

- Nitrogen and phosphorus elevated throughout
- Some sites with high chloride
- Physical habitat parameters generally good

Little Gunpowder Falls

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (µeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
LIGU-102-R-2003	7.31	208.7	612.2	34.733	1.876	8.261	0.0108	0.007	0.0004	0.005	2.066	1.127	9.50	4.50
LIGU-108-R-2003	7.30	187.2	516.3	30.460	1.821	7.417	0.0065	0.004	0.0024	0.004	1.926	1.194	9.30	6.30
LIGU-111-R-2003	6.60	254.9	337.1	26.476	12.776	8.374	0.2897	0.273	0.0151	0.208	13.947	2.500	NS	NS
LIGU-113-R-2003	6.58	34.9	180.1	2.608	0.288	1.617	0.0971	0.018	0.0066	0.152	0.914	5.204	5.80	4.30
LIGU-114-R-2003	6.60	155.6	209.6	6.263	3.979	26.564	0.0196	0.001	0.0033	0.007	4.359	1.232	9.70	4.00
LIGU-115-R-2003	7.32	211.9	709.3	32.031	2.059	11.282	0.0090	0.006	0.0004	0.006	2.226	1.286	10.10	2.90
LIGU-201-R-2003	7.12	131.7	401.2	16.626	2.385	7.536	0.0487	0.015	0.0068	0.041	2.696	2.320	8.80	2.20
LIGU-217-R-2003	7.14	131.5	376.1	17.395	2.403	7.444	0.0451	0.015	0.0066	0.038	2.706	2.288	9.60	2.00
LIGU-303-R-2003	7.21	131.2	353.2	17.862	2.495	7.354	0.0415	0.012	0.0057	0.038	2.796	2.073	8.30	3.00
LIGU-307-R-2003	7.42	154.1	398.2	22.496	2.782	8.541	0.0237	0.009	0.0047	0.030	3.022	1.211	8.30	4.00

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
LIGU-102-R-2003	50	50	OF	FR	15	16	16	14	27	15	51	7	100	16	61
LIGU-108-R-2003	50	15	FR	PA	17	18	14	15	35	16	44	20	95	7	72
LIGU-111-R-2003	0	0	PA	PA	NS	NS	NS	NS	NS	NS	NS	NS	NS	9	NS
LIGU-113-R-2003	50	45	FR	PA	4	3	5	3	75	2	0	65	97	2	10
LIGU-114-R-2003	50	35	FR	CR	15	17	9	8	17	15	60	30	96	14	27
LIGU-115-R-2003	50	50	FR	FR	16	16	16	15	33	15	60	30	98	11	93
LIGU-201-R-2003	50	15	OF	DI	14	12	14	14	65	15	15	40	80	14	94
LIGU-217-R-2003	50	50	FR	OF	16	14	16	15	50	16	40	45	50	15	81
LIGU-303-R-2003	50	50	FR	FR	18	16	18	18	50	18	30	27	85	16	119
LIGU-307-R-2003	50	50	FR	FR	17	18	17	14	40	18	75	25	50	16	65

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
LIGU-102-R-2003	N	N	N	N	Moderate	Moderate	Minor
LIGU-108-R-2003	N	N	N	Y	Mild	Moderate	Minor
LIGU-113-R-2003	N	N	N	N	Mild	Mild	Minor
LIGU-114-R-2003	N	N	N	N	Severe	Moderate	Extensive
LIGU-115-R-2003	N	N	N	N	Moderate	Moderate	Minor
LIGU-201-R-2003	Y	N	N	N	Mild	Moderate	Moderate
LIGU-217-R-2003	N	N	N	N	Severe	Mild	Minor
LIGU-303-R-2003	N	N	N	N	Moderate	Mild	Moderate
LIGU-307-R-2003	N	N	N	N	Mild	Mild	Minor

Little Gunpowder Falls

Fish Species Present

AMERICAN EEL
BLACKNOSE DACE
BLUEGILL
COMMON SHINER
CREEK CHUB
CUTLIPS MINNOW
LARGEMOUTH BASS
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
RAINBOW TROUT
REDBREAST SUNFISH
RIVER CHUB
ROCK BASS
ROSYFACE SHINER
ROSYSIDE DACE
SATINFIN SHINER
SEA LAMPREY
SHIELD DARTER
SMALLMOUTH BASS
SWALLOWTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER

Exotic Plants Present

MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM
GIANT HOGWEED

Benthic Taxa Present

ACRONEURIA
ALLOCAPNIA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
ANTOCHA
BRILLIA
CAPNIIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMIDAE
CLINOCERA
CLINOTANYPUS
CORBICULA
CORDULEGASTER
CORIXIDAE
CRANGONYX
DIAMESA
DIPLECTRONA
DOLICHOPODIDAE
DUBIRAPHIA
ECCOPTURA
ECTOPRIA
ENCHYTRAEIDAE
EPEORUS
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
EURYLOPHELLA
GOMPHIDAE
HAGENIUS
HELENIELLA
HELICHUS
HELISOMA
HEPTAGENIIDAE
HYDROBAENUS
HYDROPSYCHE
ISONYCHIA
LEPTOPHLEBIIDAE
LEPTOXIS
LIMNEPHILIDAE
LUMBRICULIDAE
LYPE
MICROPSECTRA
MICROTENDIPES
NAIDIDAE
NANOCLADIUS
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAKIEFFERIELLA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PHAENOPSECTRA
PHYSELLA
PISIDIUM
POLYCENTROPUS
PROBEZZIA
PROSIMULIUM
PROSTOIA
PROTOPLASA
PSEPHENUS
PSEUDOCHIRONOMUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
RHEOTANYTARSUS
RHYACOPHILA
SIMULIIDAE
SIMULIUM
SMITTIA
SPHAERIIDAE
SPHAERIUM
STEGOPTERNA
STENACRON
STENONEMA
STROPHOPTERYX
SYMPOTTHASTIA
TAENIOPTERYX
TALLAPERLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA

Herpetofauna Present

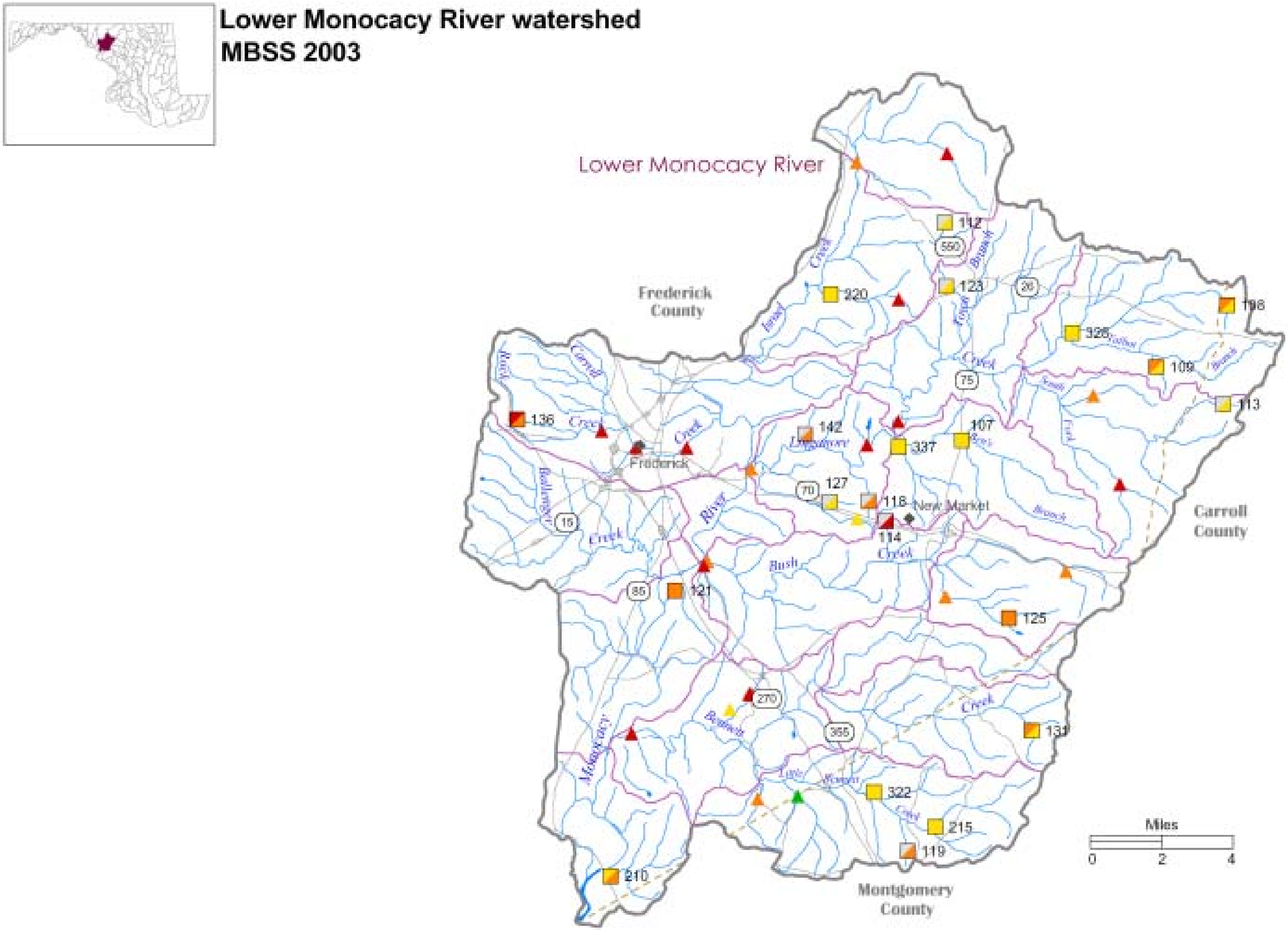
AMERICAN TOAD
BULLFROG
COMMON SNAPPING TURTLE
GREEN FROG
LONGTAIL SALAMANDER
NORTHERN TWO-LINED SALAMANDER
PICKEREL FROG
REDBACK SALAMANDER

Little Gunpowder Falls

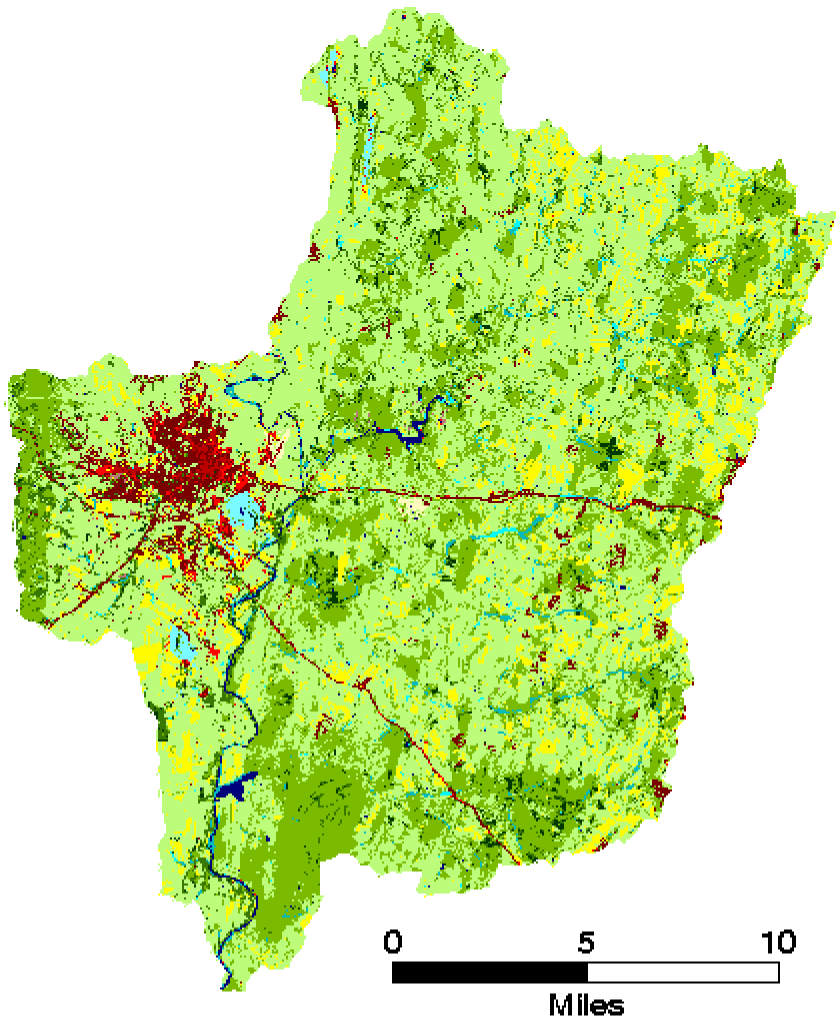
Stream Waders Data

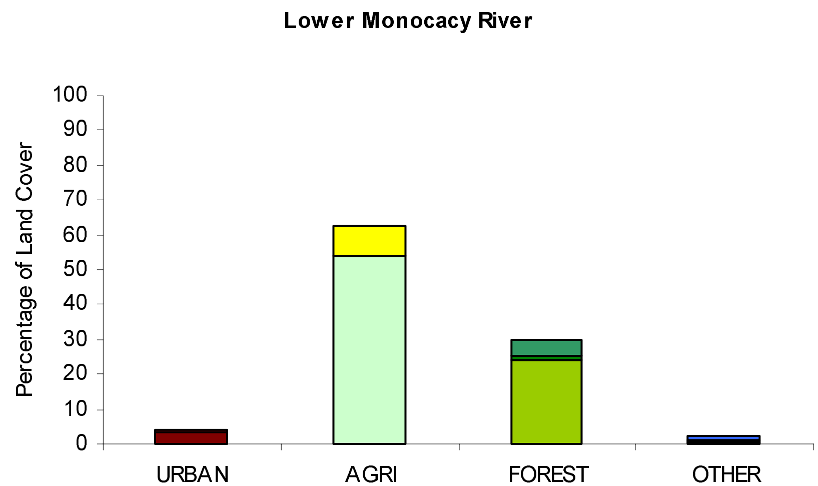
Site	8-digit Watershed	Stream Name	Benthic IBI
299-1-2003	Little Gunpowder Falls	Little Gunpowder Falls	2.43
298-8-2003	Little Gunpowder Falls	Little Gunpowder Falls	2.71
299-9-2003	Little Gunpowder Falls	Little Gunpowder Falls	2.71
298-6-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.29
298-7-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.29
298-97-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.29
298-9-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.86
298-96-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.86
298-98-2003	Little Gunpowder Falls	Little Gunpowder Falls	3.86
298-13-2003	Little Gunpowder Falls	Little Gunpowder Falls UT	3.86
299-2-2003	Little Gunpowder Falls	Nelson Br.	3.00
299-3-2003	Little Gunpowder Falls	Parker Br.	3.00
299-8-2003	Little Gunpowder Falls	Sawmill Br.	2.71
299-6-2003	Little Gunpowder Falls	Sawmill Br.	3.00
299-7-2003	Little Gunpowder Falls	Sawmill Br. UT	3.86

Lower Monocacy River watershed
MBSS 2003



Lower Monocacy River





Lower Monocacy River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
LMON-107-R-2003	BENS BR UT1	021403020234	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	2-Apr-03	16-Jun-03	1	1375
LMON-108-R-2003	WELDON CR	021403020238	Lower Monocacy River	MIDDLE POTOMAC RIVER	Carroll	2-Apr-03	17-Jun-03	1	488
LMON-109-R-2003	TALBOT BR UT1	021403020238	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	2-Apr-03	17-Jun-03	1	396
LMON-112-R-2003	CABBAGE RUN UT1	021403020237	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	2-Apr-03	25-Jun-03	1	60
LMON-113-R-2003	SOUTH FORK LINGANORE CR UT1	021403020235	Lower Monocacy River	MIDDLE POTOMAC RIVER	Carroll	2-Apr-03	16-Jun-03	1	142
LMON-114-R-2003	BUSH CR UT2	021403020229	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	19-Mar-03	11-Jun-03	1	21
LMON-118-R-2003	LAKE LINGANORE UT1	021403020232	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	19-Mar-03	1-Jul-03	1	120
LMON-119-R-2003	LITTLE BENNETT CR UT1	021403020223	Lower Monocacy River	MIDDLE POTOMAC RIVER	Montgomery	19-Mar-03	16-Jun-03	1	138
LMON-121-R-2003	MONOCACY R UT4	021403020227	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	19-Mar-03	24-Jun-03	1	1092
LMON-123-R-2003	TOWN BR UT1	021403020236	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	6-Mar-03	24-Jun-03	1	197
LMON-125-R-2003	CHURCH BR OF BUSH CR UT1	021403020228	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	19-Mar-03	11-Jun-03	1	574
LMON-127-R-2003	LONG BR UT1	021403020232	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	19-Mar-03	10-Sep-03	1	238
LMON-131-R-2003	BENNETT CR	021403020225	Lower Monocacy River	MIDDLE POTOMAC RIVER	Montgomery	19-Mar-03	6-Aug-03	1	573
LMON-136-R-2003	ROCK CR (MP)	021403020233	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	6-Mar-03	16-Jun-03	1	947
LMON-142-R-2003	LINGANORE LAKE UT	021403020232	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	30-Apr-03	2-Jul-03	1	247
LMON-210-R-2003	FURNACE BR	021403020222	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	3-Apr-03	1-Jul-03	2	2597
LMON-215-R-2003	LITTLE BENNETT CR	021403020223	Lower Monocacy River	MIDDLE POTOMAC RIVER	Montgomery	19-Mar-03	24-Jun-03	2	2342
LMON-220-R-2003	ISRAEL CR UT1	021403020237	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	2-Apr-03	6-Aug-03	2	2390
LMON-322-R-2003	LITTLE BENNETT CR	021403020223	Lower Monocacy River	MIDDLE POTOMAC RIVER	Montgomery	19-Mar-03	1-Jul-03	3	6302
LMON-328-R-2003	NORTH FORK LINGANORE CR	021403020238	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	8-Apr-03	21-Aug-03	3	6252
LMON-337-R-2003	BENS BR	021403020234	Lower Monocacy River	MIDDLE POTOMAC RIVER	Frederick	3-Apr-03	21-Aug-03	3	9909

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
LMON-107-R-2003	3.00	3.89	70.24	0	0
LMON-108-R-2003	2.14	3.22	76.28	0	0
LMON-109-R-2003	2.71	3.67	78.68	0	0
LMON-112-R-2003	NR	3.44	80.61	0	0
LMON-113-R-2003	NR	3.00	72.37	0	0
LMON-114-R-2003	NR	1.67	71.37	0	0
LMON-118-R-2003	NR	2.78	50.7	0	0
LMON-119-R-2003	NR	2.78	82.47	0	0
LMON-121-R-2003	2.43	2.33	78.6	0	0
LMON-123-R-2003	NR	3.22	58	0	0
LMON-125-R-2003	2.71	2.78	64.15	0	0
LMON-127-R-2003	NS	3.89	NS	NS	NS
LMON-131-R-2003	2.71	3.44	89.06	0	0
LMON-136-R-2003	1.00	2.56	78.31	0	0
LMON-142-R-2003	NR	2.78	71.75	0	0
LMON-210-R-2003	3.86	2.56	82.89	0	0
LMON-215-R-2003	3.00	3.44	89.5	0	0
LMON-220-R-2003	3.00	3.22	75.77	0	0
LMON-322-R-2003	3.00	3.89	85.36	0	0
LMON-328-R-2003	3.57	3.00	77.6	0	0
LMON-337-R-2003	3.57	3.67	76.76	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
LMON-107-R-2003	0.21	81.53	16.85	1.41	0.06
LMON-108-R-2003	0.91	28.66	70.25	0.18	0.69
LMON-109-R-2003	0.11	39.00	60.72	0.17	0.06
LMON-112-R-2003	0.00	73.06	26.94	0.00	0.00
LMON-113-R-2003	0.31	82.66	16.25	0.78	0.16
LMON-114-R-2003	3.16	86.32	10.53	0.00	1.84
LMON-118-R-2003	9.41	58.86	31.73	0.00	7.06
LMON-119-R-2003	0.00	52.52	46.83	0.65	0.00
LMON-121-R-2003	6.60	68.26	24.81	0.33	4.89
LMON-123-R-2003	2.70	42.41	54.22	0.67	0.67
LMON-125-R-2003	4.53	67.23	28.00	0.23	1.13
LMON-127-R-2003	2.15	74.30	22.71	0.84	0.58
LMON-131-R-2003	3.69	38.69	57.61	0.00	1.25
LMON-136-R-2003	5.44	17.10	77.37	0.09	3.56
LMON-142-R-2003	0.00	16.97	81.31	1.72	0.00
LMON-210-R-2003	0.03	34.08	65.69	0.21	0.01
LMON-215-R-2003	4.19	57.07	38.58	0.16	1.08
LMON-220-R-2003	0.57	49.49	49.79	0.16	0.15
LMON-322-R-2003	2.05	52.03	45.74	0.18	0.55
LMON-328-R-2003	0.35	69.47	29.70	0.48	0.25
LMON-337-R-2003	1.28	69.27	28.68	0.76	0.56
Overall PSU					

Lower Monocacy River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
LMON-107-R-2003	8.30	338.4	2304.0	19.163	4.857	13.106	0.0415	0.011	0.0119	0.005	5.010	1.637	8.70	7.70
LMON-108-R-2003	7.05	92.3	262.2	14.816	1.092	3.477	0.0108	0.001	0.0004	0.005	1.128	0.743	8.80	3.30
LMON-109-R-2003	7.19	115.4	405.8	13.931	1.635	5.712	0.0138	0.004	0.0038	0.004	1.678	0.990	8.70	4.40
LMON-112-R-2003	6.79	113.2	282.0	10.180	4.280	6.719	0.0112	0.004	0.0024	0.005	4.420	0.716	8.50	3.00
LMON-113-R-2003	6.70	109.6	165.0	17.208	3.353	3.530	0.0089	0.001	0.0017	0.003	3.377	0.609	8.80	4.60
LMON-114-R-2003	7.31	435.1	2332.1	58.997	0.177	16.304	0.0155	0.008	0.0004	0.005	0.343	2.176	7.60	3.00
LMON-118-R-2003	8.46	344.9	1420.8	46.341	2.181	22.413	0.0219	0.005	0.0034	0.005	2.452	1.587	8.00	15.00
LMON-119-R-2003	6.61	70.9	85.1	10.786	0.823	7.475	0.0047	0.001	0.0004	0.003	0.930	0.918	8.00	2.80
LMON-121-R-2003	7.51	267.4	534.5	43.243	4.379	13.842	0.0304	0.023	0.0037	0.007	4.942	1.998	8.20	2.50
LMON-123-R-2003	6.79	121.3	280.0	17.659	2.231	6.909	0.1055	0.037	0.0049	0.103	2.641	3.883	10.10	2.20
LMON-125-R-2003	7.26	133.1	286.3	19.826	2.838	5.701	0.0133	0.004	0.0023	0.004	3.084	1.026	8.00	5.80
LMON-127-R-2003	7.40	266.0	919.2	38.497	1.482	16.750	0.0181	0.004	0.0032	0.008	1.729	2.030	NS	NS
LMON-131-R-2003	7.34	225.7	297.2	46.384	2.431	8.943	0.0054	0.001	0.0004	0.003	2.620	0.871	8.70	0.40
LMON-136-R-2003	7.59	522.7	662.2	148.357	1.132	15.366	0.0315	0.005	0.0043	0.020	1.315	3.248	8.80	3.60
LMON-142-R-2003	7.16	85.2	341.9	6.882	0.052	11.404	0.0137	0.001	0.0013	0.005	0.122	1.100	7.70	2.10
LMON-210-R-2003	7.49	86.3	356.9	5.806	2.068	7.876	0.0138	0.005	0.0028	0.002	2.153	1.842	9.10	3.30
LMON-215-R-2003	8.39	201.8	396.4	35.731	3.181	7.559	0.0081	0.003	0.0041	0.002	3.412	1.058	8.80	1.60
LMON-220-R-2003	7.39	123.3	461.9	11.607	1.913	9.071	0.0548	0.035	0.0077	0.007	2.018	1.566	7.60	1.70
LMON-322-R-2003	8.27	161.9	357.7	25.559	2.560	7.788	0.0097	0.004	0.0045	0.002	2.789	1.104	8.80	0.90
LMON-328-R-2003	8.05	237.0	1195.0	21.026	3.598	11.386	0.0495	0.011	0.0123	0.019	3.763	1.790	9.10	9.50
LMON-337-R-2003	8.69	221.5	1303.0	18.714	2.782	12.530	0.0201	0.003	0.0075	0.005	2.860	1.371	7.60	4.00

Summary of Watershed Condition

- Nitrogen elevated throughout
- Chloride elevated at many sites
- Physical habitat parameters generally good – some channelization and buffer breaks

Lower Monocacy River

Physical Habitat Condition

Site	Riparian Buffer Width Left(m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
LMON-107-R-2003	20	50	PV	FR	16	16	15	14	35	16	56	30	93	13	76
LMON-108-R-2003	50	50	LN	LN	15	10	8	9	10	16	75	35	95	17	40
LMON-109-R-2003	50	50	FR	FR	16	17	10	10	15	16	70	25	80	15	38
LMON-112-R-2003	50	50	OF	OF	10	11	9	5	28	11	56	40	90	16	16
LMON-113-R-2003	50	0	FR	PA	6	8	9	6	19	10	67	40	95	18	21
LMON-114-R-2003	50	50	FR	FR	9	14	9	7	36	10	42	25	88	7	22
LMON-118-R-2003	50	5	OF	PA	7	5	7	6	40	7	35	55	55	16	20
LMON-119-R-2003	50	50	FR	FR	14	12	10	10	33	13	46	40	95	20	34
LMON-121-R-2003	50	50	FR	FR	13	15	14	13	36	15	39	25	93	15	75
LMON-123-R-2003	0	0	PA	PA	9	11	9	8	25	11	59	40	93	16	38
LMON-125-R-2003	10	50	PV	FR	13	12	10	9	28	15	65	40	90	15	42
LMON-127-R-2003	50	3	FR	LN	NS	NS	NS	NS	NS	NS	NS	NS	NS	15	NS
LMON-131-R-2003	50	50	FR	FR	8	13	10	8	48	15	39	35	96	19	46
LMON-136-R-2003	40	30	PV	PV	10	12	16	11	6	12	75	25	98	17	71
LMON-142-R-2003	50	50	TG	FR	6	6	6	2	34	6	41	20	92	19	16
LMON-210-R-2003	50	50	FR	FR	12	10	11	11	29	16	55	35	95	17	52
LMON-215-R-2003	50	50	FR	FR	17	17	17	18	40	18	62	20	80	17	92
LMON-220-R-2003	50	50	LN	CP	15	9	12	14	58	12	61	40	92	15	60
LMON-322-R-2003	50	50	FR	FR	16	16	17	17	45	16	44	20	90	17	93
LMON-328-R-2003	50	50	FR	FR	16	6	13	16	38	15	47	60	93	16	80
LMON-337-R-2003	50	50	FR	FR	16	13	15	15	55	16	30	35	83	15	108

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
LMON-107-R-2003	N	N	N	N	Moderate	Moderate	Moderate
LMON-108-R-2003	N	N	N	N	None	None	Minor
LMON-109-R-2003	N	N	N	N	Mild	Mild	None
LMON-112-R-2003	N	N	N	N	Moderate	Mild	Minor
LMON-113-R-2003	Y	N	N	N	Moderate	Moderate	Minor
LMON-114-R-2003	Y	N	N	Y	Moderate	Moderate	Minor
LMON-118-R-2003	Y	N	N	N	Severe	Severe	Moderate
LMON-119-R-2003	N	N	N	N	Mild	Mild	None
LMON-121-R-2003	N	N	N	N	Moderate	Moderate	Moderate
LMON-123-R-2003	Y	N	N	N	Moderate	Moderate	Moderate
LMON-125-R-2003	N	N	N	N	Mild	Mild	Minor
LMON-127-R-2003	N	N	N	N	NS	NS	NS
LMON-131-R-2003	N	N	N	N	Moderate	Moderate	Extensive
LMON-136-R-2003	N	N	N	Y	None	None	None
LMON-142-R-2003	Y	N	N	N	Moderate	Moderate	Moderate
LMON-210-R-2003	N	N	N	N	Mild	Mild	Moderate
LMON-215-R-2003	N	N	N	N	Moderate	Moderate	Moderate
LMON-220-R-2003	N	N	N	N	Mild	Moderate	Moderate
LMON-322-R-2003	Y	N	N	N	Moderate	Moderate	Extensive
LMON-328-R-2003	N	N	N	N	Moderate	Mild	Extensive
LMON-337-R-2003	N	N	N	N	Moderate	Severe	Extensive

Lower Monocacy River

Fish Species Present

AMERICAN EEL
BLACKNOSE DACE
BLUE RIDGE SCULPIN
BLUEGILL
BLUNTNOSE MINNOW
CENTRAL STONEROLLER
COMMON SHINER
CREEK CHUB
CREEK CHUBSUCKER
FALLFISH
FANTAIL DARTER
GREEN SUNFISH
GREENSIDE DARTER
LARGEMOUTH BASS
LONGEAR SUNFISH
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
POTOMAC SCULPIN
PUMPKINSEED
RAINBOW DARTER
REDBREAST SUNFISH
ROCK BASS
ROSYSIDE DACE
SPOTFIN SHINER
SPOTTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present

MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM

Benthic Taxa Present

ACERPENNA
ALLOCAPNIA
ALLOPERLA
AMELETUS
AMPHINEMURA
ANCHYTARSUS
BAETIDAE
BAETIS
BRILLIA
CAENIS
CALOPTERYX
CAMBARIDAE
CAPNIIDAE
CERATOPOGON
CERATOPOGONIDAE
CHAETOCLADIUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMIDAE
CHIRONOMINAE
CHIRONOMINI
CHRYSOPS
CLINOCERA
CLIOPERLA
CONCHAPELOPIA
CORYNONEURA
CRANGONYCTIDAE
CRANGONYX
CRICOTOPUS
CRYPTOCHIRONOMUS
DIAMESA
DIAMESINAE
DICRANOTA
DIPLECTRONA
DIPTERA
DOLICHOPODIDAE
DUGESIA
ECCOPTURA
ECTOPRIA
ELMIDAE
ENCHYTRAEIDAE
EPHEMERELLA
EUKIEFFERIELLA
EURYLOPHELLA
FERRISSIA
GOMPHIDAE
GORDIIDAE
HELENIELLA
HELICHUS
HEMERODROMIA
HEPTAGENIIDAE
HETEROTRISSOCLADIUS
HEXATOMA
HYDROBAENUS
HYDROPHILIDAE
HYDROPSYCHE
HYDROPSYCHIDAE
ISONYCHIA
ISOPERLA
ISOTOMURUS
LEPIDOSTOMA
LEPTOPHLEBIA
LEPTOPHLEBIIDAE
LEUCTRA
LEUCTRIDAE
LIMNEPHILIDAE
LIMNOPHYES
LUMBRICULIDAE
LYPE
MENETUS
MICROPSECTRA
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NATARSIA
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARACAPNIA
PARAKIEFFERIELLA
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PARATANYTARSUS
PERICOMA
PERLODIDAE
PHAENOPSECTRA
PHYSELLA
PISIDIUM
PLECOPTERA
POLYCENTROPUS
POLYPEDILUM
POTTHASTIA
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PTERONARCYS
PTILOSTOMIS
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
RHYACOPHILA
SERRATELLA
SIALIS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
SPHAERIUM
SPIROSPERMA
STEGOPTERNA
STEMPELLINELLA
STENELMIS
STENONEMA
STROPHOPTERYX
STYLOGOMPHUS
SUBLETTEA
SWELTSA
SYMPOSIOCLADIUS
SYMPOTTHASTIA
TABANIDAE
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
WORMALDIA
ZAVRELIMYIA

Herpetofauna Present

COMMON SNAPPING TURTLE
EASTERN BOX TURTLE
GREEN FROG
NORTHERN DUSKY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
RED SALAMANDER

Lower Monocacy River

Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
224-3-2003	Lower Monocacy River	Bennet Cr.	1.29
229-1-2003	Lower Monocacy River	Bush Cr.	2.71
228-2-2003	Lower Monocacy River	Bush Cr. UT	2.71
233-1-2003	Lower Monocacy River	Carroll Cr.	1.29
233-2-2003	Lower Monocacy River	Carroll Cr.	1.29
228-1-2003	Lower Monocacy River	Church Br.	2.43
232-3-2003	Lower Monocacy River	Indian Cave Cr.	1.57
239-1-2003	Lower Monocacy River	Israel Cr.	2.43
239-2-2003	Lower Monocacy River	Israel Cr. UT	1.29
237-1-2003	Lower Monocacy River	Israel Cr. UT	1.86
236-4-2003	Lower Monocacy River	Linganore Cr.	1.29
232-2-2003	Lower Monocacy River	Linganore Cr.	2.43
223-2-2003	Lower Monocacy River	Little Bennett Cr. UT	2.71
223-1-2003	Lower Monocacy River	Little Bennett Cr. UT	4.14
232-1-2003	Lower Monocacy River	Long Br.	3.00
229-2-2003	Lower Monocacy River	Monocacy R. UT	1.86
233-3-2003	Lower Monocacy River	Rock Cr.	1.29
235-2-2003	Lower Monocacy River	South Fork UT.	2.43
224-4-2003	Lower Monocacy River	Urbana Br. UT	1.57
224-1-2003	Lower Monocacy River	Urbana Br. UT	1.86
224-2-2003	Lower Monocacy River	Urbana Br. UT	3.00
235-1-2003	Lower Monocacy River	Woodville Br.	1.57

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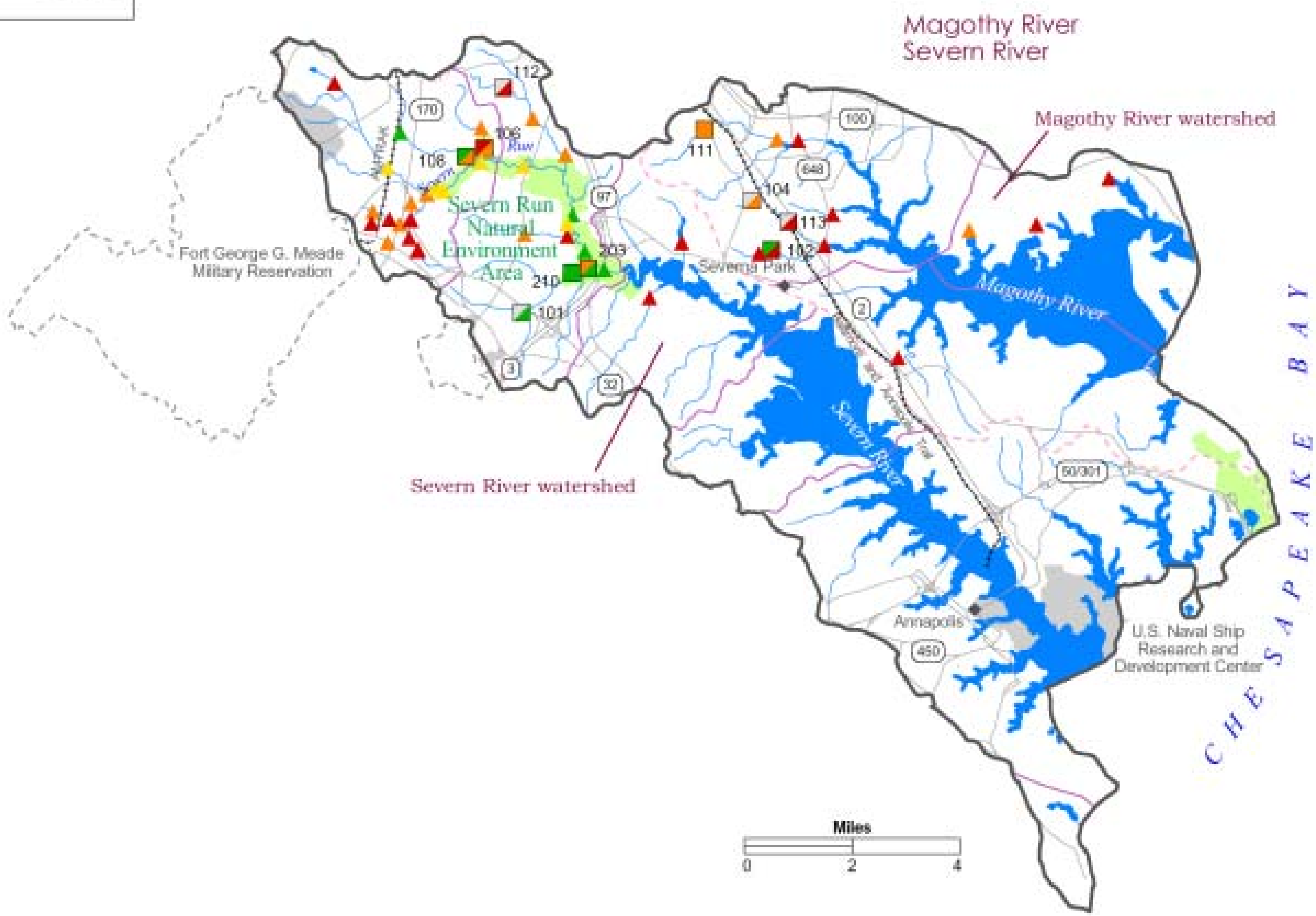
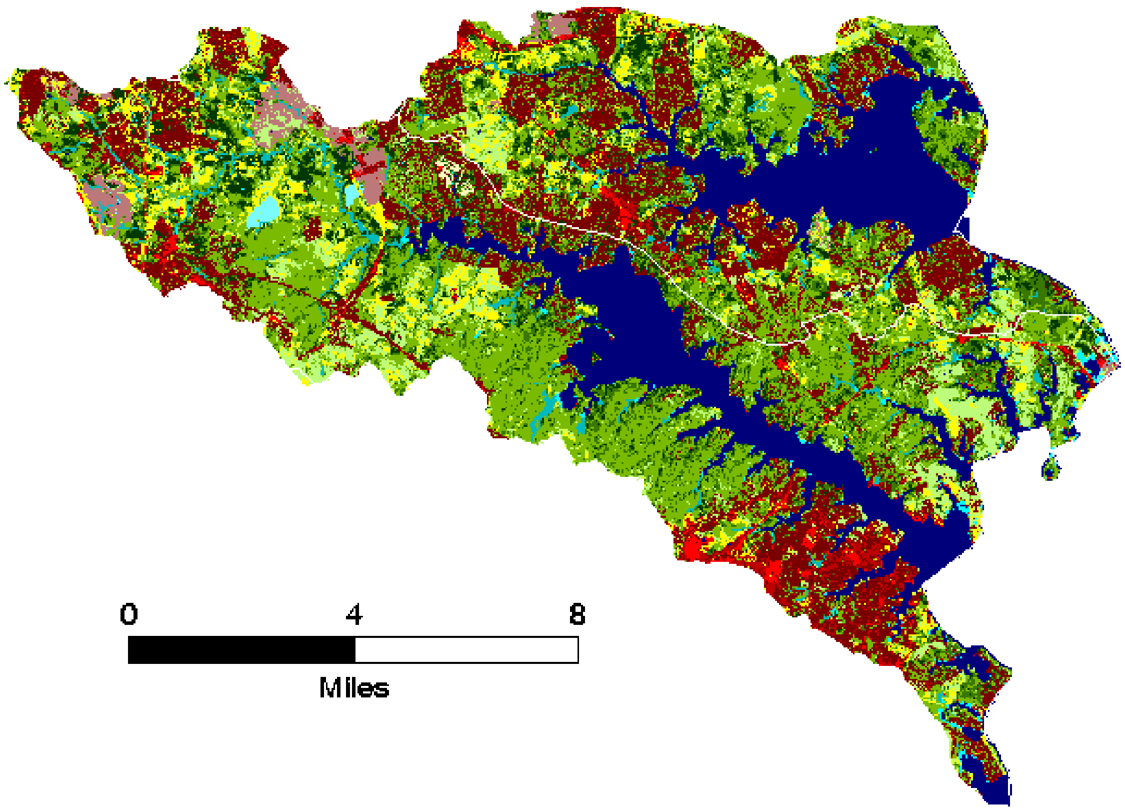
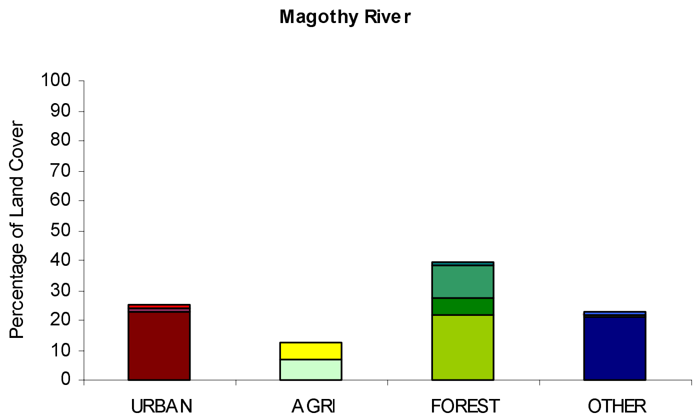
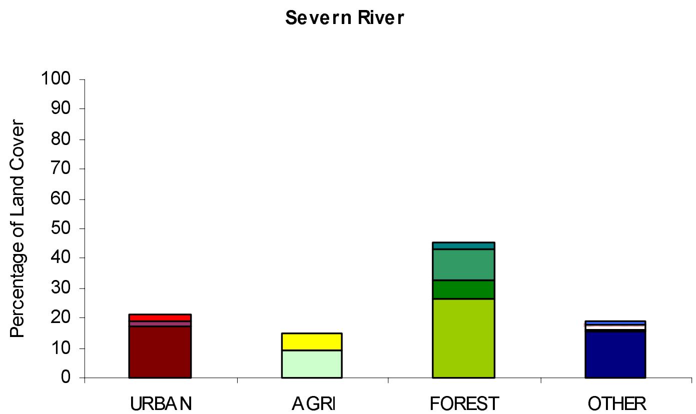
Magothy River/ Severn River watersheds MBSS 2003



Magothy/Severn Rivers







Magothy/Severn Rivers

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
MAGO-102-R-2003	CATTAIL CR (WC) UT2	021310011005	Magothy River	WEST CHESAPEAKE BAY	Anne Arundel	10-Mar-03	16-Jun-03	1	487
MAGO-104-R-2003	LAKE WATERFORD UT2	021310011005	Magothy River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	16-Jun-03	1	225
MAGO-111-R-2003	LAKE WATERFORD UT1	021310011005	Magothy River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	28-Jul-03	1	568
MAGO-113-R-2003	CATTAIL CR (WC) UT1	021310011005	Magothy River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	28-Jul-03	1	138
SEVE-101-R-2003	JABEZ BR	021310021001	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	10-Mar-03	16-Jun-03	1	779
SEVE-106-R-2003	SEVERN RUN UT4	021310021002	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	28-Jul-03	1	670
SEVE-108-R-2003	SEVERN RUN UT3	021310021002	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	10-Jun-03	1	1437
SEVE-112-R-2003	SEVERN RUN UT1	021310021001	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	11-Mar-03	10-Jun-03	1	271
SEVE-203-R-2003	JABEZ BR	021310021001	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	10-Mar-03	11-Jun-03	2	3378
SEVE-210-R-2003	JABEZ BR	021310021001	Severn River	WEST CHESAPEAKE BAY	Anne Arundel	10-Mar-03	11-Jun-03	2	2533

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
MAGO-102-R-2003	2.00	1.86	59.43	0	0
MAGO-104-R-2003	NR	2.43	68.12	0	0
MAGO-111-R-2003	3.00	2.14	66.94	0	0
MAGO-113-R-2003	NS	1.57	NS	NS	NS
SEVE-101-R-2003	NR	4.14	79.91	1	0
SEVE-106-R-2003	3.25	2.43	69.08	0	0
SEVE-108-R-2003	2.25	2.71	77.45	0	0
SEVE-112-R-2003	NR	1.57	68.73	0	1
SEVE-203-R-2003	3.00	4.71	69.93	0	0
SEVE-210-R-2003	2.25	4.71	60.3	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
MAGO-102-R-2003	44.13	17.82	37.64	0.41	12.88
MAGO-104-R-2003	10.08	57.09	31.94	0.90	2.72
MAGO-111-R-2003	43.17	9.32	46.97	0.55	10.93
MAGO-113-R-2003	16.61	17.59	65.47	0.33	4.40
SEVE-101-R-2003	25.12	13.06	61.79	0.03	7.29
SEVE-106-R-2003	15.48	18.83	64.83	0.86	4.23
SEVE-108-R-2003	52.03	15.31	31.92	0.75	20.00
SEVE-112-R-2003	28.40	21.19	50.25	0.16	8.08
SEVE-203-R-2003	17.87	25.16	56.87	0.11	9.45
SEVE-210-R-2003	14.45	24.38	61.05	0.11	6.03
Overall PSU					

Summary of Watershed Condition

- Five sites in urban catchments
- Low ANC at five sites
- Chloride high at five sites
- High turbidity at five sites
- Physical habitat parameters generally good

Magothy/Severn Rivers

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (ueq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
MAGO-102-R-2003	6.39	324.1	503.9	69.808	0.310	19.524	0.0316	0.009	0.0004	0.031	0.547	4.426	1.70	6.50
MAGO-104-R-2003	6.73	259.8	862.9	34.476	0.516	25.658	0.0291	0.006	0.0026	0.031	0.901	7.653	6.40	12.90
MAGO-111-R-2003	6.66	218.4	222.0	41.721	1.372	19.873	0.0131	0.001	0.0024	0.015	1.647	7.862	5.20	5.20
MAGO-113-R-2003	5.69	161.3	56.3	17.734	0.034	40.205	0.0124	0.003	0.0004	0.012	0.220	4.748	1.40	14.10
SEVE-101-R-2003	6.37	139.4	139.6	28.107	0.885	8.207	0.0376	0.013	0.0012	0.085	1.130	4.117	8.50	16.00
SEVE-106-R-2003	6.08	153.4	89.6	26.354	0.268	19.506	0.0238	0.001	0.0004	0.008	0.513	7.627	7.30	23.50
SEVE-108-R-2003	6.50	255.0	261.4	47.087	0.958	27.448	0.0091	0.001	0.0014	0.014	1.246	6.105	8.30	3.70
SEVE-112-R-2003	5.21	246.2	18.6	20.481	0.335	38.034	0.0074	0.001	0.0004	0.005	0.590	9.035	7.10	2.00
SEVE-203-R-2003	6.66	169.4	179.0	33.891	0.926	11.946	0.0326	0.003	0.0018	0.055	1.120	3.904	9.40	10.60
SEVE-210-R-2003	6.50	154.5	142.6	29.832	0.904	11.850	0.0254	0.002	0.0018	0.048	1.082	4.198	8.80	8.10

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
MAGO-102-R-2003	50	50	LN	LN	6	6	5	8	60	9	15	100	70	6	40
MAGO-104-R-2003	40	45	HO	HO	7	8	7	8	61	9	18	50	85	11	37
MAGO-111-R-2003	30	30	HO	PV	10	8	8	9	52	11	29	30	80	6	38
MAGO-113-R-2003	50	50	FR	TG	NS	NS	NS	NS	NS	NS	NS	NS	NS	16	NS
SEVE-101-R-2003	50	50	FR	FR	12	11	11	11	32	11	47	55	96	14	56
SEVE-106-R-2003	50	50	FR	FR	12	10	11	11	59	11	20	50	95	14	58
SEVE-108-R-2003	50	50	FR	FR	13	13	14	15	32	15	50	10	98	13	76
SEVE-112-R-2003	50	50	FR	FR	6	7	8	7	48	11	27	100	95	13	45
SEVE-203-R-2003	50	50	FR	FR	9	11	16	13	19	15	73	30	90	12	54
SEVE-210-R-2003	50	50	FR	FR	7	6	12	12	5	14	75	80	92	14	76

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
MAGO-102-R-2003	N	N	N	N	Mild	Mild	Minor
MAGO-104-R-2003	Y	N	N	N	Mild	Mild	Minor
MAGO-111-R-2003	N	N	N	N	None	None	Moderate
MAGO-113-R-2003	N	N	N	Y	None	None	
SEVE-101-R-2003	N	N	N	N	Moderate	Mild	Moderate
SEVE-106-R-2003	N	N	N	N	Moderate	Moderate	Moderate
SEVE-108-R-2003	N	N	N	N	Mild	Mild	None
SEVE-112-R-2003	N	N	N	N	None	None	Minor
SEVE-203-R-2003	N	N	N	N	Moderate	Moderate	Minor
SEVE-210-R-2003	N	N	N	N	Moderate	Moderate	Minor

Magothy/Severn Rivers

Fish Species Present
AMERICAN EEL
BLACKNOSE DACE
BLUEGILL
BROOK TROUT
CHAIN PICKEREL
EASTERN MUDMINNOW
GOLDEN SHINER
GREEN SUNFISH
MOSQUITOFISH
PUMPKINSEED
REDFIN PICKEREL
TESSELLATED DARTER
WHITE SUCKER
YELLOW PERCH

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
MICROSTEGIUM

Benthic Taxa Present
ACERPENNA
AGABUS
ALLOCAPNIA
ANCHYTARSUS
ANCYRONYX
ANTOCHA
BEZZIA
BOYERIA
CAECIDOTEA
CALOPTERYX
CERATOPOGON
CERATOPOGONIDAE
CHAETOCLADIUS
CHAULIODES
CHEUMATOPSYCHE
CHLOROPERLIDAE
CHRYSOPS
COENAGRIONIDAE
COLLEMBOLA
CORDULEGASTER
CULEX
DICRANOTA
DINEUTUS
DIPLECTRONA
DIPLOCLADIUS
DIPTERA
DOLICHOPODIDAE
ECCOPTURA
ENCHYTRAEIDAE
EPHEMEROPTERA
EUKIEFFERIELLA
HELICHUS
HELOCOMBUS
HETEROPLECTRON
HETEROTRISSOCLADIUS
HEXATOMA
HYDATOPHYLAX
HYDROBAENUS
HYDROPHILIDAE
HYDROPORUS
HYDROPSYCHE
IRONOQUIA
ISOTOMURUS
LEPTOPHLEBIA
LEPTOPHLEBIIDAE
LEUCTRA
LIMNEPHILIDAE
LIMNOPHYES
LIMONIA
LUMBRICULIDAE
LYPE
MACRONYCHUS
MESOSMITTIA
MICROPSECTRA
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NEMOURIDAE
NIGRONIA
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARACHAETOCLADIUS
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PHYSELLA
PLATYCENTROPUS
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEUDORTHOCLADIUS
PTILOSTOMIS
PYCNOPSYCHE
PYRALIDAE
RHEOTANYTARSUS
ROBACKIA
SIALIS
SPHAERIIDAE
STEGOPTERNA
STENELMIS
STILOCLADIUS
STRATIOMYS
SYMPOSIOCLADIUS
SYNURELLA
TANYPODINAE
TANYTARSINI
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TORTRICIDAE
TRIAENODES
TRIBELOS
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
ZALUTSCHIA
ZAVRELIMYIA

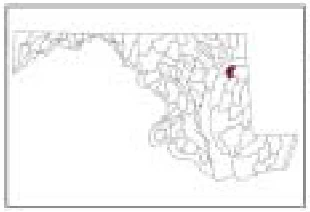
Herpetofauna Present
AMERICAN TOAD
BULLFROG
COMMON SNAPPING TURTLE
EASTERN BOX TURTLE
EASTERN SMOOTH EARTH SNAKE
EASTERN WORM SNAKE
FOWLER'S TOAD
GREEN FROG
NORTHERN RED BELLY SNAKE
NORTHERN SPRING PEEPER
NORTHERN TWO-LINED SALAMANDER
PICKEREL FROG

Magothy/Severn Rivers

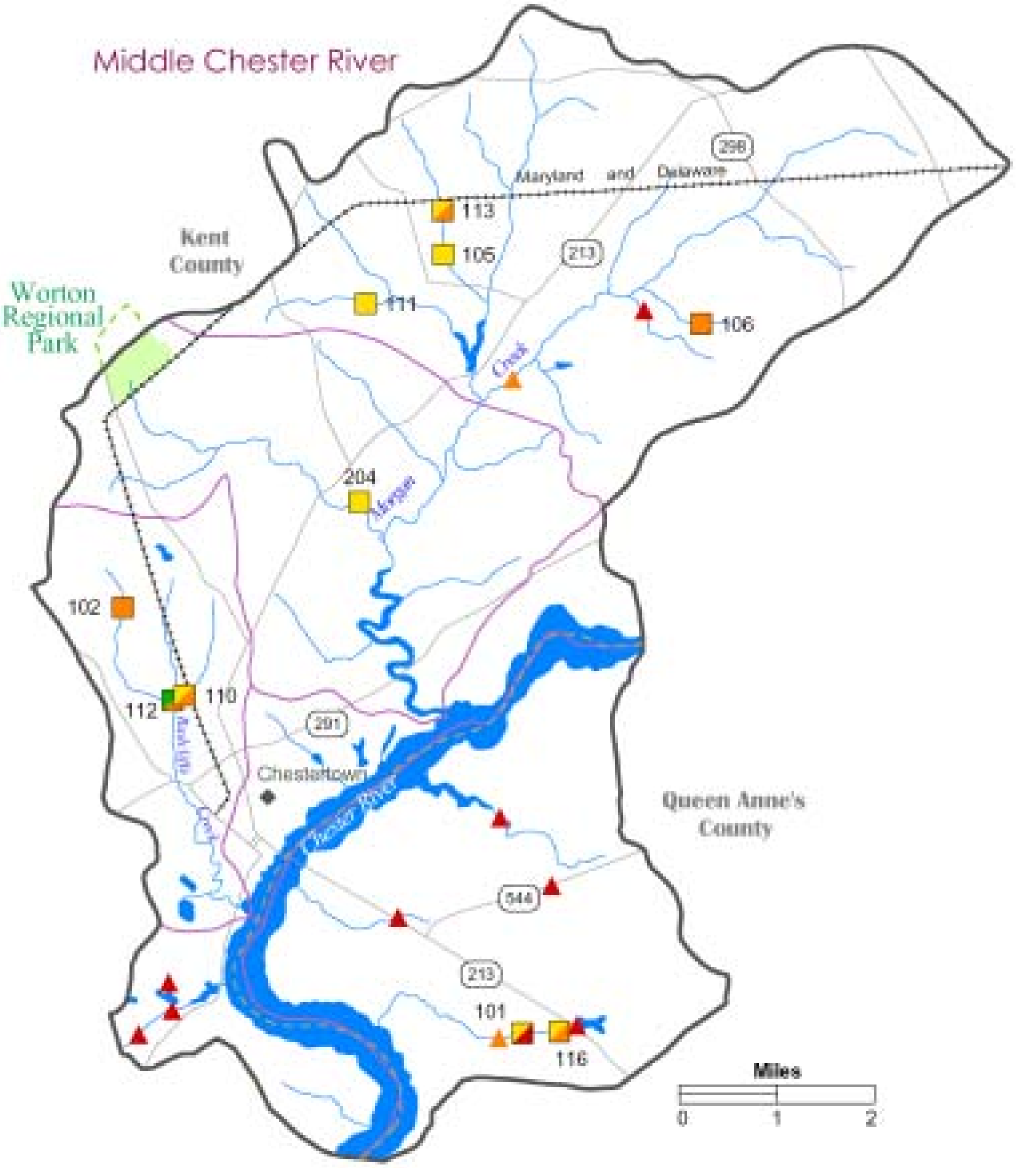
Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
1004-1-2003	Magothy River	Black Hole Cr.	2.14
1004-2-2003	Magothy River	Branch Grays Cr.	1.86
1005-6-2003	Magothy River	Cattail Cr.	1.00
1004-3-2003	Magothy River	Cornfield Cr.	1.57
1005-4-2003	Magothy River	Cottontail Cr.	1.29
1003-1-2003	Magothy River	Dividing Cr.	1.00
1005-7-2003	Magothy River	Magothy Br.	2.71
1005-3-2003	Magothy River	Old Mac Cr.	1.57
1005-0-2003	Magothy River	Upper Magothy R.	1.29
1002-7-2003	Severn River	Picture Spring Br.	1.29
1002-9-2003	Severn River	Picture Spring Br.	1.29
1002-97-2003	Severn River	Picture Spring Br.	1.29
1002-5-2003	Severn River	Picture Spring Br.	1.86
1002-1-2003	Severn River	Picture Spring Br.	2.43
1002-6-2003	Severn River	Picture Spring Br.	2.43
1002-10-2003	Severn River	Picture Spring Br.	2.71
1002-80-2003	Severn River	Picture Spring Br.	2.71
1002-2-2003	Severn River	Picture Spring Br. UT	1.29
1002-92-2003	Severn River	Picture Spring Br. UT	1.29
1002-3-2003	Severn River	Picture Spring Br. UT	1.00
1002-4-2003	Severn River	Picture Spring Br. UT	2.14
1002-8-2003	Severn River	Picture Spring Br. UT	2.71
999-9-2003	Severn River	Severn R. UT	1.57
1002-16-2003	Severn River	Severn Run	1.00
1002-11-2003	Severn River	Severn Run	3.00
1001-2-2003	Severn River	Severn Run	3.29
1002-12-2003	Severn River	Severn Run	3.29
1002-81-2003	Severn River	Severn Run	3.29
1002-82-2003	Severn River	Severn Run	3.29
1002-13-2003	Severn River	Severn Run	3.86
1002-17-2003	Severn River	Severn Run	3.86
1001-5-2003	Severn River	Severn Run	4.14
1001-4-2003	Severn River	Severn Run	4.43
1001-8-2003	Severn River	Severn Run	4.43
1001-6-2003	Severn River	Severn Run UT	1.57
1001-3-2003	Severn River	Severn Run UT	2.43
1001-1-2003	Severn River	Severn Run UT	2.71
1001-9-2003	Severn River	Severn Run UT	2.71
1002-14-2003	Severn River	Severn Run UT	2.71
1001-7-2003	Severn River	Severn Run UT	3.29
1002-15-2003	Severn River	Severn Run UT	4.14
999-6-2003	Severn River	Sewell Spring Br.	1.29

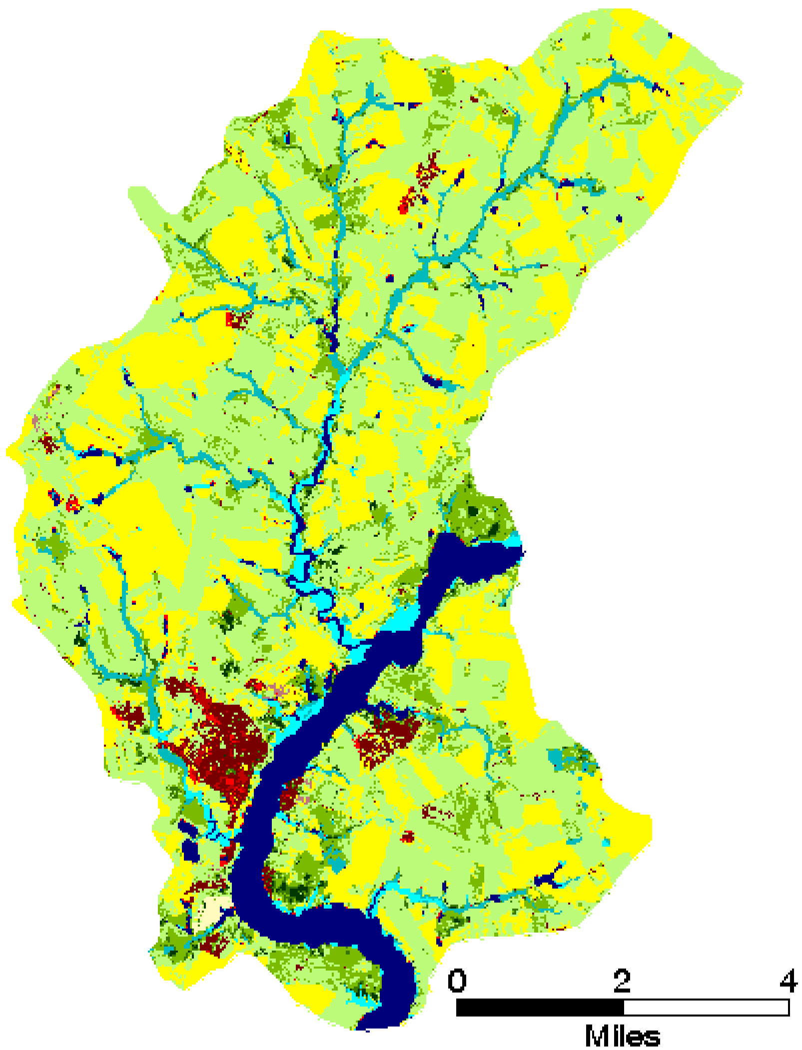
Middle Chester River

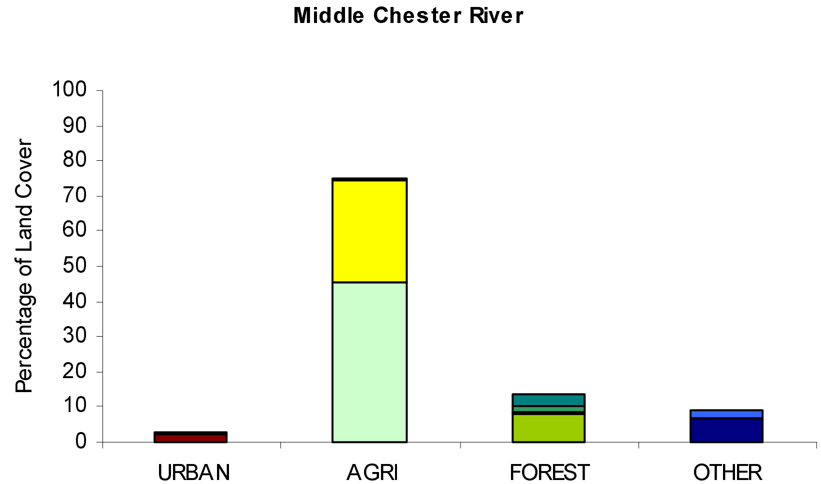


Middle Chester River watershed
MBSS 2003



Middle Chester River





Middle Chester River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
MICR-101-R-2003	HAMBLETON CR	021305090412	Middle Chester River	CHESTER RIVER	Queen Anne's	1-Apr-03	30-Jun-03	1	1280
MICR-102-R-2003	RADCLIFFE CR	021305090411	Middle Chester River	CHESTER RIVER	Kent	1-Apr-03	17-Jun-03	1	418
MICR-105-R-2003	URIEVILLE LAKE UT1 UT1	021305090415	Middle Chester River	CHESTER RIVER	Kent	2-Apr-03	24-Jun-03	1	812
MICR-106-R-2003	MORGAN CR UT5	021305090415	Middle Chester River	CHESTER RIVER	Kent	1-Apr-03	24-Jun-03	1	348
MICR-110-R-2003	RADCLIFFE CR UT2	021305090411	Middle Chester River	CHESTER RIVER	Kent	1-Apr-03	17-Jun-03	1	605
MICR-111-R-2003	URIEVILLE LAKE UT2 UT1	021305090415	Middle Chester River	CHESTER RIVER	Kent	2-Apr-03	23-Jul-03	1	594
MICR-112-R-2003	RADCLIFFE CR UT1	021305090411	Middle Chester River	CHESTER RIVER	Kent	1-Apr-03	17-Jun-03	1	593
MICR-113-R-2003	URIEVILLE LAKE UT1 UT1	021305090415	Middle Chester River	CHESTER RIVER	Kent	2-Apr-03	24-Jun-03	1	544
MICR-116-R-2003	HAMBLETON CR	021305090412	Middle Chester River	CHESTER RIVER	Queen Anne's	2-Apr-03	23-Jul-03	1	1064
MICR-204-R-2003	MORGAN CR UT2	021305090414	Middle Chester River	CHESTER RIVER	Kent	2-Apr-03	23-Jul-03	2	2873

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
MICR-101-R-2003	3.25	1.86	84.21	0	0
MICR-102-R-2003	2.50	2.71	72.93	0	0
MICR-105-R-2003	3.25	3.00	65.29	0	0
MICR-106-R-2003	2.75	2.43	79.23	0	0
MICR-110-R-2003	3.25	2.14	71.39	0	0
MICR-111-R-2003	3.50	3.00	64.13	0	0
MICR-112-R-2003	4.00	2.43	83.56	0	0
MICR-113-R-2003	3.50	2.71	68.36	0	0
MICR-116-R-2003	3.50	2.71	76.54	0	0
MICR-204-R-2003	3.50	3.00	68.82	0	0

Catchment Land Use

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
MICR-101-R-2003	0.66	88.34	8.09	2.91	0.28
MICR-102-R-2003	0.48	80.90	17.56	1.07	0.17
MICR-105-R-2003	0.71	86.97	12.31	0.00	0.19
MICR-106-R-2003	1.02	95.78	3.20	0.00	0.26
MICR-110-R-2003	0.77	94.14	3.59	1.50	0.50
MICR-111-R-2003	2.48	92.59	4.74	0.19	1.26
MICR-112-R-2003	0.41	85.79	12.18	1.62	0.31
MICR-113-R-2003	0.94	87.89	11.17	0.00	0.26
MICR-116-R-2003	0.69	88.02	8.38	2.91	0.27
MICR-204-R-2003	1.44	85.04	10.70	2.82	0.67
Overall PSU					

Summary of Watershed Condition

- All sites in agricultural watersheds
- Nitrogen and phosphorus elevated at all sites
- Physical habitat parameters generally good

Middle Chester River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
MICR-101-R-2003	7.16	155.2	473.8	17.056	3.661	9.121	0.0371	0.004	0.0473	0.098	4.203	4.088	9.30	4.30
MICR-102-R-2003	6.61	158.7	351.6	12.951	4.550	14.840	0.1831	0.079	0.0191	0.058	5.449	16.690	5.60	17.60
MICR-105-R-2003	7.08	143.4	347.2	14.825	4.155	9.393	0.0255	0.005	0.0060	0.008	4.312	3.097	7.80	5.80
MICR-106-R-2003	6.22	140.3	287.8	13.355	4.772	9.472	0.0546	0.009	0.0044	0.018	4.860	1.429	5.50	8.50
MICR-110-R-2003	6.54	157.3	524.7	20.872	2.247	7.066	0.0871	0.004	0.0048	0.008	2.458	2.285	5.40	8.40
MICR-111-R-2003	7.02	210.1	203.2	22.637	10.596	10.194	0.0666	0.010	0.0251	0.007	10.628	1.969	7.00	9.20
MICR-112-R-2003	7.02	153.2	490.2	14.276	4.051	10.619	0.0428	0.006	0.0192	0.040	4.236	4.049	6.40	10.90
MICR-113-R-2003	6.43	128.6	228.4	12.155	4.493	10.278	0.0230	0.008	0.0048	0.007	4.743	3.345	7.40	8.30
MICR-116-R-2003	6.67	169.7	552.3	13.610	5.718	6.816	0.0377	0.001	0.0398	0.375	6.816	3.036	5.90	3.00
MICR-204-R-2003	7.42	211.2	818.7	20.166	3.350	14.346	0.1341	0.013	0.0404	0.098	3.676	4.423	6.20	20.60

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
MICR-101-R-2003	40	50	CP	FR	14	15	14	13	39	15	40	10	92	19	67
MICR-102-R-2003	50	35	TG	CP	8	7	7	7	54	11	21	50	75	19	35
MICR-105-R-2003	50	35	OF	CP	11	9	14	15	65	16	17	50	30	20	56
MICR-106-R-2003	0	0	CP	PV	14	15	8	11	75	10	5	100	85	18	51
MICR-110-R-2003	15	50	CP	FR	12	11	12	14	66	11	9	40	70	16	75
MICR-111-R-2003	50	28	FR	CP	7	6	7	8	20	16	55	35	70	19	39
MICR-112-R-2003	50	50	OF	FR	16	17	14	13	54	16	21	100	20	20	63
MICR-113-R-2003	50	15	FR	CP	7	6	8	10	25	15	50	100	98	20	44
MICR-116-R-2003	25	50	CP	FR	13	15	8	11	75	0	0	100	40	16	50
MICR-204-R-2003	50	50	FR	FR	14	15	14	17	55	16	44	80	80	16	106

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
MICR-101-R-2003	N	N	N	N	None	None	Minor
MICR-102-R-2003	N	N	N	N	None	None	Minor
MICR-105-R-2003	N	N	N	N	None	None	None
MICR-106-R-2003	Y	N	N	N	None	None	None
MICR-110-R-2003	N	N	N	N	Moderate	Moderate	Minor
MICR-111-R-2003	N	N	N	N	Mild	Moderate	Minor
MICR-112-R-2003	N	N	N	N	Mild	Mild	None
MICR-113-R-2003	N	N	N	N	Mild	Mild	None
MICR-116-R-2003	N	N	N	N	None	None	Minor
MICR-204-R-2003	N	N	N	N	Moderate	Moderate	Minor

Middle Chester River

Fish Species Present
AMERICAN EEL
BLACK CRAPPIE
BLUEGILL
BLUESPOTTED SUNFISH
BROWN BULLHEAD
CREEK CHUBSUCKER
EASTERN MUDMINNOW
FATHEAD MINNOW
GOLDEN SHINER
GREEN SUNFISH
LARGEMOUTH BASS
LEAST BROOK LAMPREY
MOSQUITOFISH
MUMMICHOG
PUMPKINSEED
REDBREAST SUNFISH
SATINFIN SHINER
TADPOLE MADTOM
TESSELLATED DARTER
WHITE PERCH
YELLOW PERCH

Exotic Plants Present
MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM

Benthic Taxa Present
ABLABESMYIA
AMPHIPODA
ANCYRONYX
APSECTROTANYPUS
ARGIA
BEZZIA
BITTACOMORPHA
CAECIDOTEA
CAENIS
CALOPTERYX
CAMBARIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIRONOMIDAE
CHIRONOMINAE
CHIRONOMINI
CHRYSOPS
CLINOTANYPUS
COENAGRIONIDAE
CONCHAPELOPIA
CORIXIDAE
CORYNONEURA
CRICOTOPUS
CRYPTOCHIRONOMUS
DICROTENDIPES
DINEUTUS
DIPLECTRONA
DIPLOCLADIUS
DOLICHOPODIDAE
DUBIRAPHIA
DUGESIA
ELMIDAE
ENCHYTRAEIDAE
EPHYDRIDAE
GAMMARUS
GLYPTOTENDIPES
GORDIIDAE
GYRINUS
HELICHUS
HYDROBIUS
HYDROPSYCHE
IRONOQUIA
ISCHNURA
LABRUNDINIA
LEPTOPHLEBIIDAE
LIMNEPHILIDAE
LUMBRICULIDAE
LYMNAEIDAE
LYPE
MACRONYCHUS
MATUS
MENETUS
MEROPELOPIA
METRIOCNEMUS
MICROPSECTRA
MICROTENDIPES
MOLANNODES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NATARSIA
NIGRONIA
OECETIS
ORTHOCLADIINAE
ORTHOCLADIUS
PARACHIRONOMUS
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PARATANYTARSUS
PARATENDIPES
PELTODYTES
PHAENOPSECTRA
PHYSELLA
PISIDIUM
PLANARIIDAE
PLANORBELLA
POLYCENTROPUS
POLYPEDILUM
PROCLADIUS
PROSIMULIUM
PROSTOMA
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PSILOTRETA
PTILOSTOMIS
PTYCHOPTERIDAE
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
SIALIS
SIMULIUM
SPHAERIIDAE
STAGNICOLA
STEGOPTERNA
STEMPELLINELLA
STENELMIS
STENOCHIRONOMUS
STRATIOMYS
SYMPOSIOCLADIUS
SYNURELLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIBELOS
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
VIVIPARIDAE
ZAVRELIMYIA

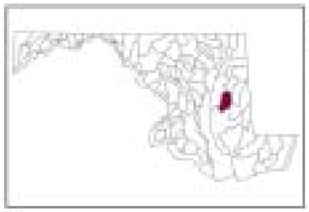
Herpetofauna Present
BULLFROG
COMMON SNAPPING TURTLE
EASTERN PAINTED TURTLE
EASTERN SPADEFOOT TOAD
FOWLER'S TOAD
GREEN FROG
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
QUEEN SNAKE
SOUTHERN LEOPARD FROG
WOOD FROG

Middle Chester River

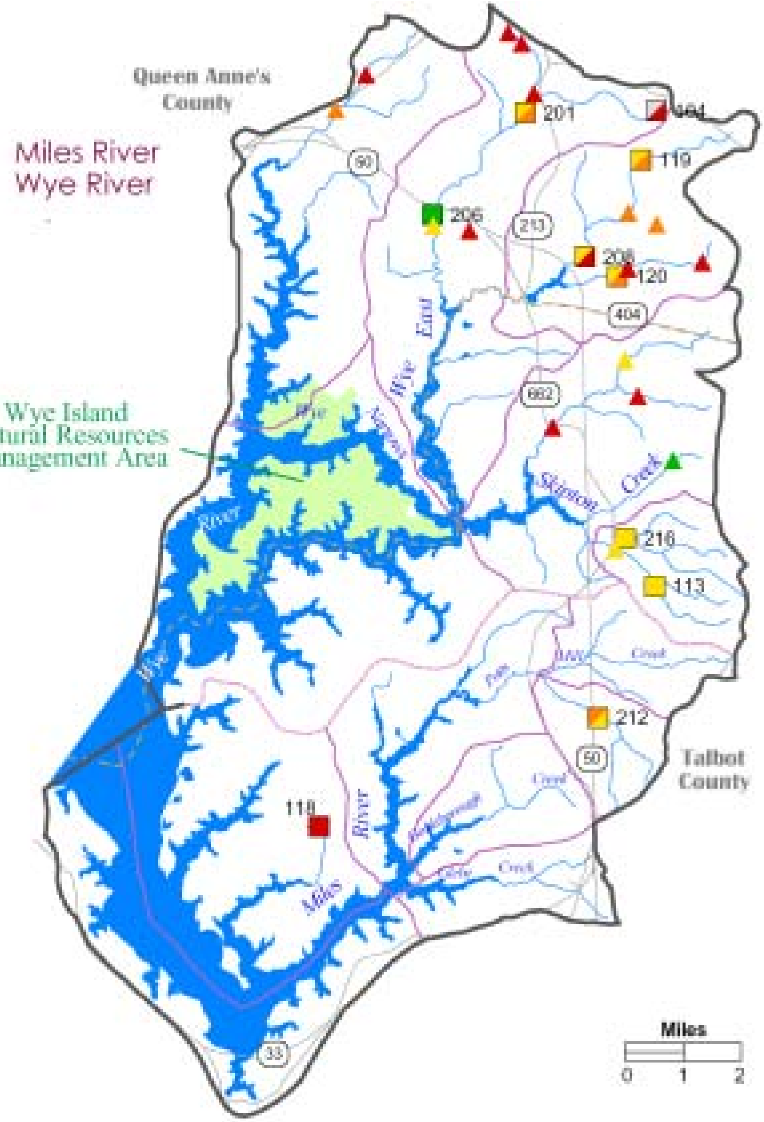
Stream Waders Data

Site	8-digit Watershed	Stream Name	Benthic IBI
410-3-2003	Middle Chester River	Chester R. UT	1.29
412-2-2003	Middle Chester River	Chester R. UT	1.00
410-1-2003	Middle Chester River	Chester R. UT	1.57
410-2-2003	Middle Chester River	Chester R. UT	1.86
412-4-2003	Middle Chester River	Hambleton Cr.	1.29
412-1-2003	Middle Chester River	Hambleton Cr.	2.14
415-1-2003	Middle Chester River	Morgan Cr.	2.43
415-4-2003	Middle Chester River	Morgan Cr. UT	1.57
412-5-2003	Middle Chester River	Rosin Cr.	1.29
412-3-2003	Middle Chester River	Rosin Cr.	1.86

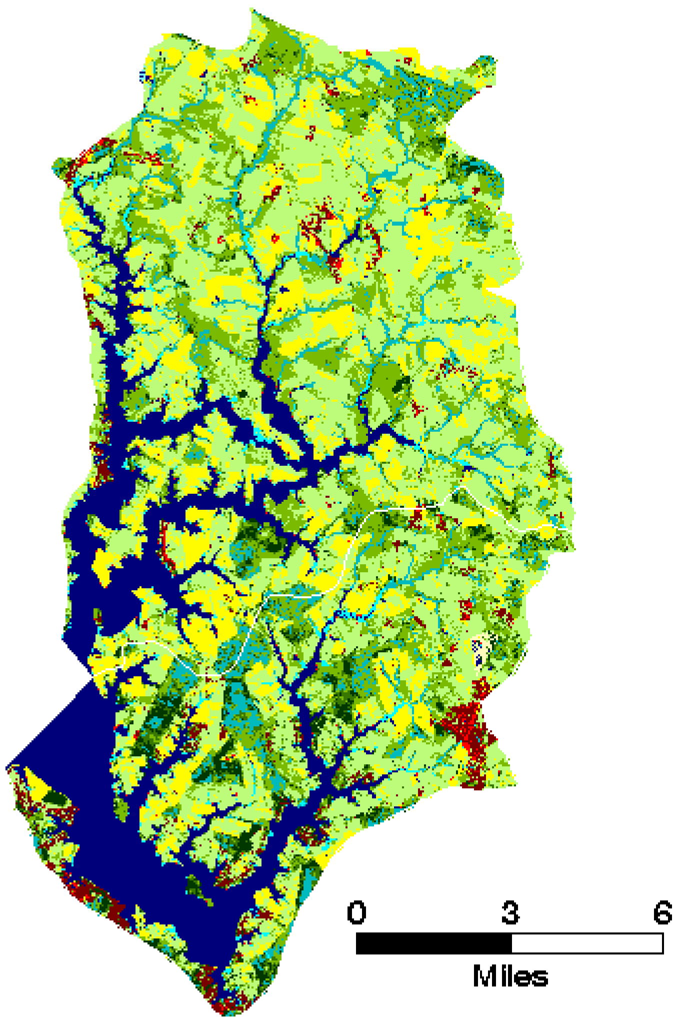
Miles/Wye Rivers

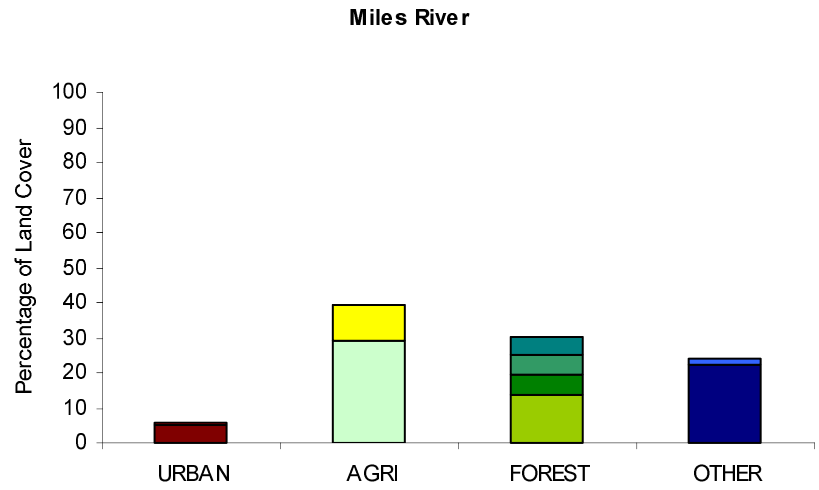


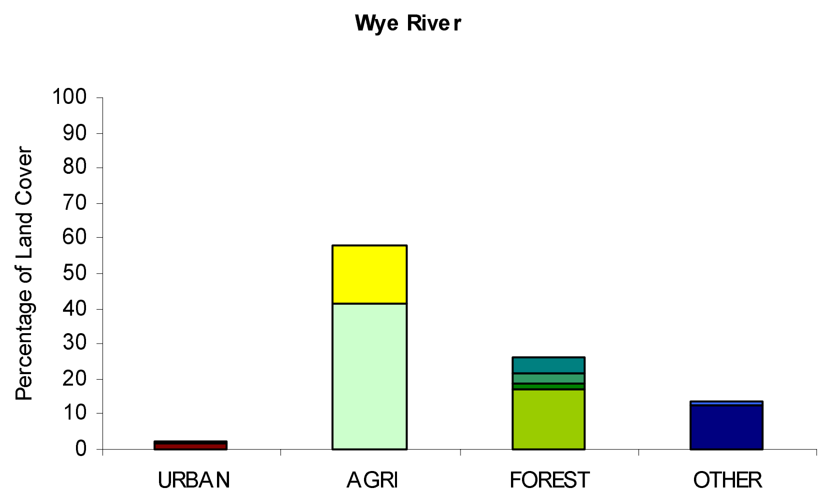
Miles River/Wye River watersheds
MBSS 2003



Miles/Wye Rivers







Miles/Wye Rivers

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
MILE-118-R-2003	HUNTING CR	021305020439	Miles River	CHESTER RIVER	Talbot	20-Mar-03	23-Jun-03	1	984
MILE-212-R-2003	POTTS MILL CR UT1	021305020442	Miles River	CHESTER RIVER	Talbot	20-Mar-03	23-Jun-03	2	1216
WYER-104-R-2003	WYE EAST R UT1 UT1	021305030436	Wye River	CHESTER RIVER	Queen Anne's	24-Apr-03	2-Jul-03	1	119
WYER-113-R-2003	SKIPTON CR	021305030434	Wye River	CHESTER RIVER	Talbot	24-Apr-03	25-Jun-03	1	692
WYER-119-R-2003	WYE MILL POND UT1	021305030437	Wye River	CHESTER RIVER	Queen Anne's	24-Apr-03	25-Jun-03	1	1045
WYER-120-R-2003	WYE MILL POND UT2	021305030437	Wye River	CHESTER RIVER	Queen Anne's	24-Apr-03	25-Jun-03	1	1188
WYER-201-R-2003	WYE EAST R UT1	021305030436	Wye River	CHESTER RIVER	Queen Anne's	24-Apr-03	21-Jul-03	2	2203
WYER-206-R-2003	WYE EAST R UT1	021305030436	Wye River	CHESTER RIVER	Queen Anne's	20-Mar-03	1-Jul-03	2	5095
WYER-208-R-2003	WYE MILL POND UT1	021305030437	Wye River	CHESTER RIVER	Queen Anne's	20-Mar-03	1-Jul-03	2	3452
WYER-216-R-2003	SKIPTON CR UT2	021305030434	Wye River	CHESTER RIVER	Talbot	20-Mar-03	23-Jun-03	2	1490

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
MILE-118-R-2003	1.50	1.57	65.78	0	0
MILE-212-R-2003	2.75	3.29	60.04	0	0
WYER-104-R-2003	NR	1.86	76.71	0	0
WYER-113-R-2003	3.75	3.00	72.9	0	0
WYER-119-R-2003	3.00	2.71	88.56	0	0
WYER-120-R-2003	3.75	2.71	69.62	0	0
WYER-201-R-2003	3.50	2.14	77.86	0	0
WYER-206-R-2003	4.00	4.14	72.95	0	0
WYER-208-R-2003	3.00	1.57	85.6	0	0
WYER-216-R-2003	3.75	3.86	67.71	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
MILE-118-R-2003	1.97	10.57	87.00	0.45	0.63
MILE-212-R-2003	9.19	50.21	39.09	1.50	3.01
WYER-113-R-2003	0.97	67.28	31.11	0.65	0.34
WYER-119-R-2003	1.20	30.23	67.72	0.85	0.40
WYER-120-R-2003	2.42	55.44	41.61	0.53	0.96
WYER-201-R-2003	1.92	46.23	51.66	0.19	0.80
WYER-206-R-2003	2.21	61.10	36.37	0.32	0.90
WYER-208-R-2003	0.82	52.62	45.92	0.65	0.31
WYER-216-R-2003	1.54	59.52	38.26	0.67	0.42
Overall PSU					

Summary of Watershed Condition

- Nitrogen and phosphorus elevated throughout
- High DOC throughout
- Six sites with 100% embeddedness
- Physical habitat parameters otherwise generally good

Miles/Wye Rivers

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
MILE-118-R-2003	6.46	214.1	517.0	23.573	0.006	34.152	0.0692	0.020	0.0037	0.050	0.697	24.974	2.20	22.20
MILE-212-R-2003	6.94	182.9	533.1	23.515	2.628	12.096	0.0880	0.017	0.0092	0.047	3.229	8.895	8.40	6.90
WYER-104-R-2003	6.85	181.0	531.0	23.188	2.921	10.708	0.0694	0.014	0.0288	0.030	3.546	11.033	4.40	9.70
WYER-113-R-2003	7.03	179.8	471.1	19.402	4.183	15.187	0.0444	0.015	0.0096	0.031	4.792	7.989	7.80	9.10
WYER-119-R-2003	6.52	72.3	271.0	7.934	0.000	4.962	0.0455	0.017	0.0004	0.018	0.647	25.728	6.50	7.00
WYER-120-R-2003	6.74	174.4	512.2	14.327	3.107	23.089	0.0750	0.029	0.0153	0.028	3.570	13.278	6.40	6.50
WYER-201-R-2003	7.21	160.0	586.4	17.680	0.606	17.521	0.1085	0.061	0.0064	0.010	1.007	11.461	6.10	13.90
WYER-206-R-2003	7.05	199.0	564.4	24.162	2.344	17.372	0.1424	0.037	0.0063	0.030	2.817	7.053	7.90	5.60
WYER-208-R-2003	6.93	172.8	589.3	13.874	2.958	16.907	0.0859	0.015	0.0103	0.225	3.770	9.417	7.80	3.40
WYER-216-R-2003	7.26	209.3	763.3	16.406	2.545	25.816	0.0471	0.023	0.0092	0.059	3.047	7.405	8.60	6.70

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
MILE-118-R-2003	10	6	CP	CP	6	7	4	9	75	0	0	100	75	19	34
MILE-212-R-2003	23	50	CP	OF	9	9	8	9	20	15	60	100	75	18	40
WYER-104-R-2003	7	7	CP	CP	10	11	4	7	75	0	0	100	25	18	40
WYER-113-R-2003	50	15	FR	CP	11	13	12	12	47	13	28	30	94	17	78
WYER-119-R-2003	50	50	FR	FR	14	14	10	14	58	12	18	100	95	20	57
WYER-120-R-2003	20	50	CP	TG	13	11	11	15	64	11	11	70	95	17	73
WYER-201-R-2003	12	50	PA	FR	14	11	6	10	75	0	0	100	90	11	42
WYER-206-R-2003	50	50	FR	FR	14	13	12	14	57	13	18	35	85	18	78
WYER-208-R-2003	50	50	FR	FR	15	16	14	14	45	15	52	25	95	17	67
WYER-216-R-2003	50	50	LN	FR	11	10	11	11	47	15	32	100	95	17	54

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
MILE-118-R-2003	N	N	N	Y	None	None	None
MILE-212-R-2003	N	N	N	N	Moderate	Moderate	Moderate
WYER-104-R-2003	N	N	N	Y	None	None	None
WYER-113-R-2003	N	N	N	N	Severe	Severe	Extensive
WYER-119-R-2003	N	N	N	N	Mild	Mild	Moderate
WYER-120-R-2003	N	N	N	N	Moderate	Moderate	Moderate
WYER-201-R-2003	N	N	N	N	None	None	Moderate
WYER-206-R-2003	N	N	N	N	Moderate	Moderate	Moderate
WYER-208-R-2003	N	N	N	N	Mild	Mild	Minor
WYER-216-R-2003	N	N	N	N	Moderate	Moderate	Moderate

Miles/Wye Rivers

Fish Species Present
AMERICAN EEL
BLACKNOSE DACE
BLUEGILL
BROWN BULLHEAD
CREEK CHUBSUCKER
EASTERN MUDMINNOW
GOLDEN SHINER
LARGEMOUTH BASS
LEAST BROOK LAMPREY
PIRATE PERCH
PUMPKINSEED
REDFIN PICKEREL
TADPOLE MADTOM
TESSELLATED DARTER
WHITE CATFISH

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM

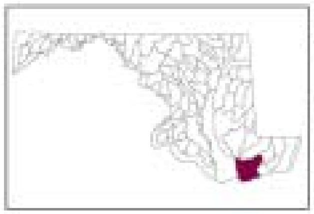
Benthic Taxa Present
ABLABESMYIA
ACERPENNA
ANCYRONYX
ARGIA
ASELLIDAE
BAETIDAE
BEZZIA
CAECIDOTEA
CALLIBAETIS
CALOPTERYX
CAPNIIDAE
CERATOPOGON
CERATOPOGONIDAE
CHAOBORUS
CHEUMATOPSYCHE
CHIRONOMIDAE
CHIRONOMINI
CHIRONOMUS
CHRYSOPS
CLINOTANYPUS
CLIOPERLA
COENAGRIONIDAE
COLLEMBOLA
COPELATUS
CORIXIDAE
CORYNONEURA
CRANGONYCTIDAE
CRICOTOPUS
DIAMESINAE
DICROTENDIPES
DIPLECTRONA
DIPLOCLADIUS
DIPTERA
DUGESIA
DYTISCIDAE
ENCHYTRAEIDAE
EURYLOPHELLA
GAMMARUS
GONIOBASIS
GYRINUS
HELICHUS
HEPTAGENIIDAE
HEXATOMA
HYDROBAENUS
HYDROBIUS
HYDROCHUS
HYDROPORUS
HYDROPSYCHE
ISOPERLA
ISOTOMURUS
LABRUNDINIA
LEPIDOPTERA
LEPTOPHLEBIA
LEPTOPHLEBIIDAE
LIMNEPHILIDAE
LIMNOPHYES
LUMBRICULIDAE
LYPE
MACRONYCHUS
MENETUS
MICROPSECTRA
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NEMOURIDAE
NIGRONIA
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
PARAKIEFFERIELLA
PARAMERINA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PARATANYTARSUS
PERLODIDAE
PHAENOPSECTRA
PHYSELLA
PLANORBELLA
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PSEUDOSUCCINEA
PYCNOPSYCHE
RHEOCRICOTOPUS
RHEOTANYTARSUS
SIMULIIDAE
SOMATOCHLORA
SPHAERIIDAE
SPHAERIUM
STAGNICOLA
STEGOPTERNA
STENELMIS
STENONEMA
STRATIOMYS
STYGONECTES
SYNURELLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRISSOPELOPIA
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present
BULLFROG
COMMON MUSK TURTLE
COMMON SNAPPING TURTLE
EASTERN BOX TURTLE
FOWLER'S TOAD
GREEN FROG
NORTHERN SPRING PEEPER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
SOUTHERN LEOPARD FROG
WOOD FROG

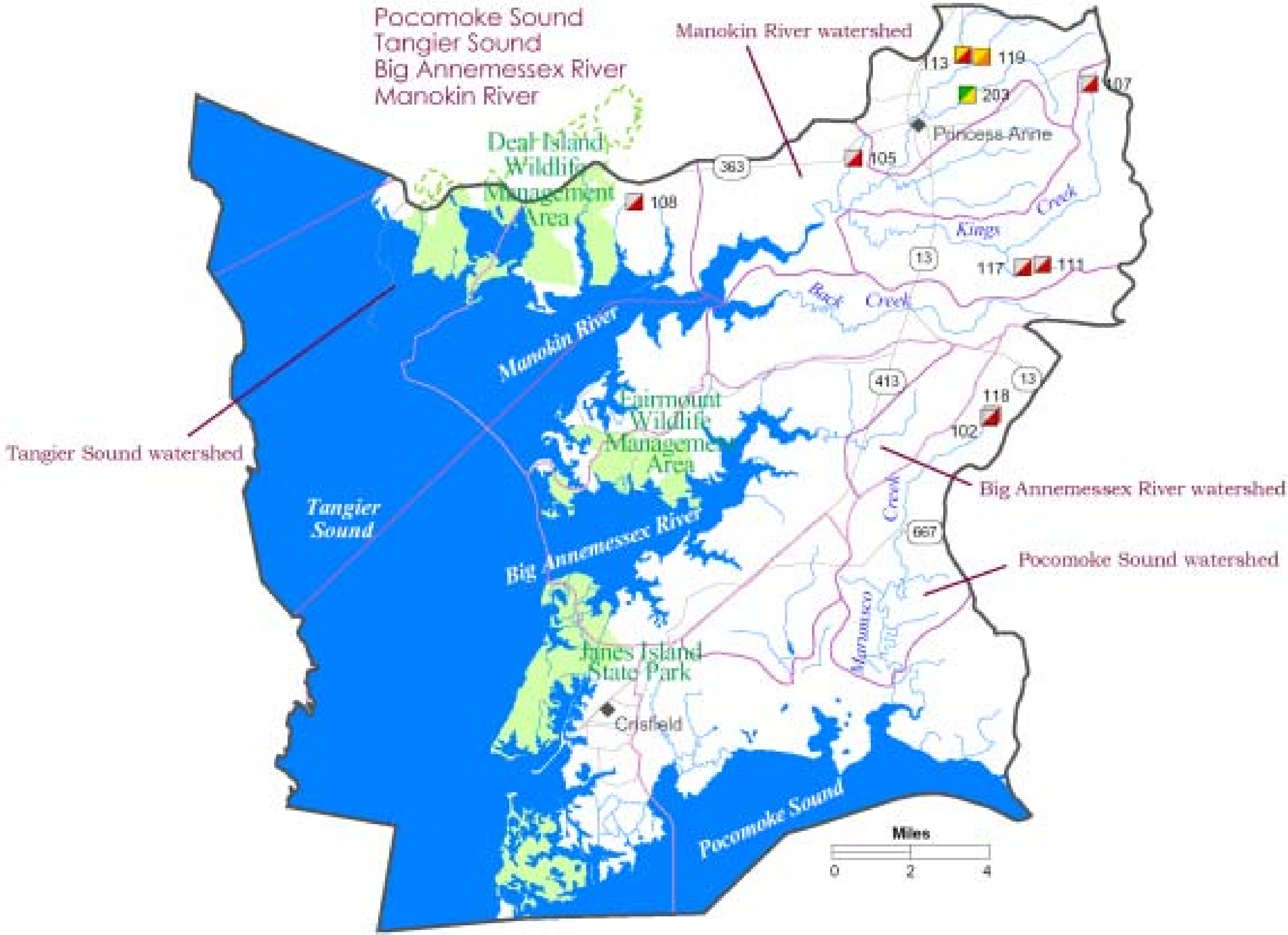
Miles/Wye Rivers

Stream Waders Data

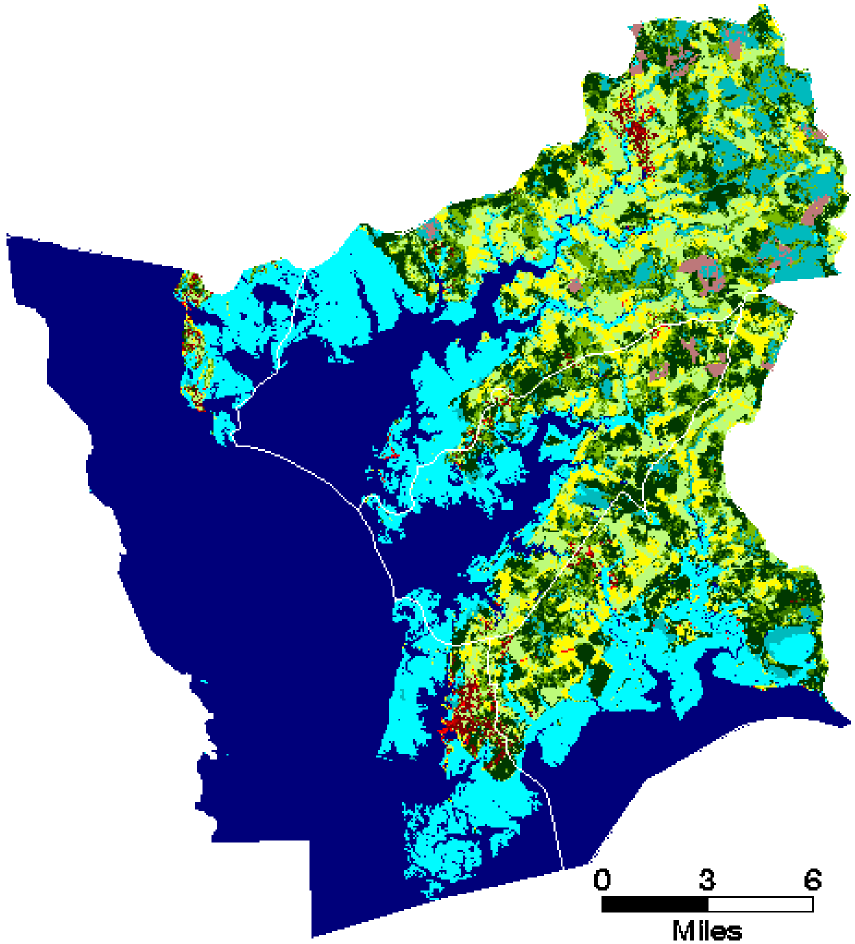
Site	8-digit Watershed	Stream Name	Benthic IBI
437-1-2003	Wye River	Golden Run	2.71
437-4-2003	Wye River	Golden Run	2.71
435-1-2003	Wye River	Mill Cr.	3.29
435-2-2003	Wye River	Mill Cr. UT	1.29
435-4-2003	Wye River	Mill Cr. UT	1.29
434-1-2003	Wye River	Skipton Cr. UT	3.00
435-3-2003	Wye River	Skipton Cr. UT	4.43
436-3-2003	Wye River	Wye East R. UT	1.29
437-5-2003	Wye River	Wye East R. UT	1.29
436-1-2003	Wye River	Wye East R. UT	1.57
436-5-2003	Wye River	Wye East R. UT	1.86
436-2-2003	Wye River	Wye East R. UT	1.29
437-3-2003	Wye River	Wye East R. UT	1.29
436-4-2003	Wye River	Wye East R. UT	3.86
433-2-2003	Wye River	Wye R. UT	2.71
433-1-2003	Wye River	Wye R. UT	1.57

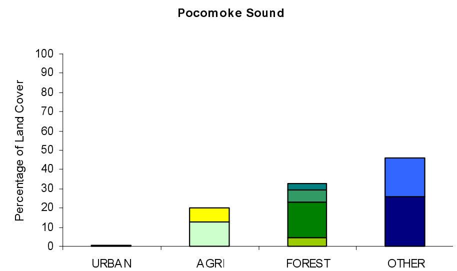


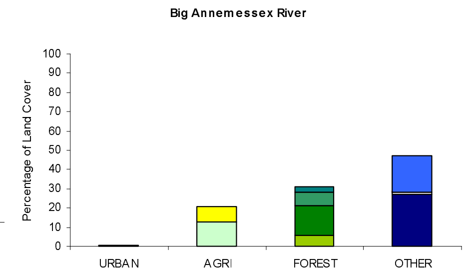
Pocomoke Sound/Tangier Sound/ Big Annemessex River/ Manokin River watersheds MBSS 2003

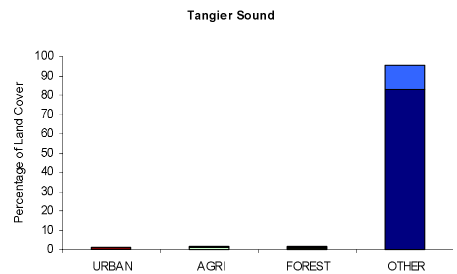


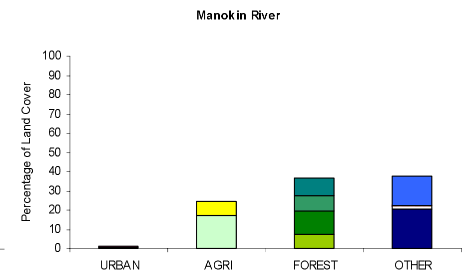
Pocomoke Sound/Tangier Sound/Big Annemessex River/Manokin River











Pocomoke Sound/Tangier Sound/Big Annemessex River/Manokin River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
MANO-105-R-2003	HALL BR	021302080659	Manokin River	POCOMOKE RIVER	Somerset	13-Mar-03	10-Jul-03	1	411
MANO-107-R-2003	KINGS CR (PC)	021302080660	Manokin River	POCOMOKE RIVER	Somerset	18-Mar-03	9-Jul-03	1	196
MANO-108-R-2003	GEANQUAKIN CR	021302080657	Manokin River	POCOMOKE RIVER	Somerset	13-Mar-03	9-Jul-03	1	176
MANO-111-R-2003	MOORE BR	021302080660	Manokin River	POCOMOKE RIVER	Somerset	12-Mar-03	8-Jul-03	1	212
MANO-113-R-2003	LORETTO BR UT1	021302080661	Manokin River	POCOMOKE RIVER	Somerset	12-Mar-03	10-Jul-03	1	651
MANO-117-R-2003	MOORE BR	021302080660	Manokin River	POCOMOKE RIVER	Somerset	18-Mar-03	8-Jul-03	1	860
MANO-119-R-2003	LORETTO BR	021302080661	Manokin River	POCOMOKE RIVER	Somerset	13-Mar-03	13-Aug-03	1	616
MANO-203-R-2003	MANOKIN BR	021302080661	Manokin River	POCOMOKE RIVER	Somerset	13-Mar-03	9-Jul-03	2	3227
PCSO-102-R-2003	MARUMSCO CR	021302010621	Pocomoke Sound	POCOMOKE RIVER	Somerset	12-Mar-03	8-Jul-03	1	2121
PCSO-118-R-2003	MARUMSCO CR	021302010621	Pocomoke Sound	POCOMOKE RIVER	Somerset	12-Mar-03	8-Jul-03	1	2065

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
MANO-105-R-2003	NR	1.86	65.93	0	1
MANO-107-R-2003	NR	1.57	79.11	0	1
MANO-108-R-2003	NR	1.00	84.35	0	1
MANO-111-R-2003	NR	1.57	81.97	0	1
MANO-113-R-2003	3.50	1.57	77.07	0	1
MANO-117-R-2003	NR	1.00	56.37	0	1
MANO-119-R-2003	3.50	2.43	68.8	0	0
MANO-203-R-2003	2.50	3.00	61.18	0	0
PCSO-102-R-2003	NR	1.57	56.06	0	1
PCSO-118-R-2003	NR	1.57	63.73	0	1

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
MANO-105-R-2003	4.22	39.32	55.92	0.54	1.43
MANO-107-R-2003	0.00	14.12	85.88	0.00	0.00
MANO-108-R-2003	0.00	24.52	75.48	0.00	0.00
MANO-111-R-2003	0.00	1.99	90.99	7.02	0.00
MANO-113-R-2003	0.00	11.49	86.29	2.22	0.00
MANO-117-R-2003	0.00	8.46	84.73	6.81	0.00
MANO-119-R-2003	0.00	26.44	66.00	7.56	0.00
MANO-203-R-2003	0.01	27.94	65.30	6.76	0.00
PCSO-102-R-2003	0.13	37.90	58.17	3.81	0.70
PCSO-118-R-2003	0.13	38.68	57.27	3.92	0.80
Overall PSU					

Summary of Watershed Condition

- Low ANC at every site
- Elevated phosphorus throughout
- Low DO, high DOC, and high turbidity throughout
- Nine sites with elevated embeddedness
- Poor physical habitat parameters – especially velocity/depth diversity and riffle/run quality
- All sites with evidence of channelization

Pocomoke Sound/Tangier Sound/Big Annemessex River/Manokin River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
MANO-105-R-2003	5.45	107.6	50.2	13.905	0.139	19.510	0.0283	0.009	0.0004	0.014	0.578	16.222	0.80	28.10
MANO-107-R-2003	4.40	73.0	-31.8	5.762	0.448	13.597	0.0112	0.001	0.0004	0.076	1.042	14.933	1.80	87.10
MANO-108-R-2003	4.50	240.9	-23.3	54.931	0.000	12.021	0.0330	0.001	0.0004	0.026	0.926	47.857	1.20	6.00
MANO-111-R-2003	4.07	97.4	-97.7	6.264	0.129	17.193	0.0089	0.001	0.0004	0.016	0.738	24.217	1.10	5.50
MANO-113-R-2003	5.05	80.9	24.2	10.609	0.009	14.297	0.0169	0.005	0.0004	0.015	0.431	15.133	1.60	45.90
MANO-117-R-2003	5.74	73.3	127.4	6.149	0.553	9.828	0.5752	0.520	0.0101	0.155	1.835	21.783	6.60	31.60
MANO-119-R-2003	5.65	95.5	60.6	11.034	0.238	19.848	0.0249	0.005	0.0022	0.019	0.569	10.004	2.70	35.80
MANO-203-R-2003	5.80	140.3	99.2	12.591	2.317	27.413	0.0374	0.007	0.0047	0.151	2.807	7.848	6.60	34.20
PCSO-102-R-2003	5.50	139.2	60.8	17.770	0.281	28.347	0.0503	0.018	0.0004	0.031	0.776	13.184	2.90	55.20
PCSO-118-R-2003	5.46	140.2	53.0	17.676	0.281	26.887	0.0468	0.017	0.0004	0.022	0.698	13.011	3.50	50.30

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
MANO-105-R-2003	0	50	CP	OF	5	6	3	7	70	6	5	100	95	14	26
MANO-107-R-2003	50	50	FR	OF	8	8	4	8	75	0	0	100	75	19	32
MANO-108-R-2003	50	50	OF	FR	8	11	4	8	75	0	0	100	65	18	30
MANO-111-R-2003	50	50	FR	FR	7	8	3	7	75	0	0	100	97	19	23
MANO-113-R-2003	50	50	FR	FR	14	13	5	9	75	0	0	100	75	19	43
MANO-117-R-2003	50	50	FR	FR	2	2	1	6	32	0	0	100	96	16	21
MANO-119-R-2003	50	50	OF	FR	11	9	6	15	75	0	0	100	20	19	115
MANO-203-R-2003	35	40	CP	CP	7	9	7	7	40	11	40	35	92	12	22
PCSO-102-R-2003	50	50	FR	FR	6	5	3	7	75	0	0	100	92	19	38
PCSO-118-R-2003	50	50	FR	FR	7	6	4	8	75	0	0	100	95	19	28

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
MANO-105-R-2003	Y	N	N	Y	Moderate	Mild	Moderate
MANO-107-R-2003	N	N	N	Y	None	None	None
MANO-108-R-2003	N	N	N	Y	None	None	Moderate
MANO-111-R-2003	N	N	N	Y	Mild	Mild	Moderate
MANO-113-R-2003	N	N	N	Y	None	None	Minor
MANO-117-R-2003	Y	N	N	Y	None	None	Extensive
MANO-119-R-2003	N	N	N	Y	None	None	None
MANO-203-R-2003	N	N	N	Y	Mild	Mild	Minor
PCSO-102-R-2003	N	N	N	Y	Moderate	Moderate	Moderate
PCSO-118-R-2003	N	N	N	Y	Moderate	Moderate	Moderate

Pocomoke Sound/Tangier Sound/Big Annemessex River/Manokin River

Fish Species Present
AMERICAN EEL
BANDED SUNFISH
BLUEGILL
BLUESPOTTED SUNFISH
BROWN BULLHEAD
CREEK CHUBSUCKER
EASTERN MUDMINNOW
GOLDEN SHINER
LARGEMOUTH BASS
MUD SUNFISH
PIRATE PERCH
PUMPKINSEED
REDFIN PICKEREL

Exotic Plants Present
MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM
PHRAGMITES

Benthic Taxa Present
AEDES
AESHNIDAE
AGABUS
ARGIA
CAECIDOTEA
CAENIS
CALOPTERYX
CAMBARIDAE
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CLINOTANYPUS
COENAGRIONIDAE
COPELATUS
CORYNONEURA
CRANGONYX
CRYPTOCHIRONOMUS
CULICIDAE
CURA
CYMBIODYTA
DERONECTES
DINEUTUS
DOLICHOPODIDAE
DUBIRAPHIA
DUGESIA
DYTISCIDAE
ENALLAGMA
ENCHYTRAEIDAE
EUKIEFFERIELLA
GAMMARUS
GOMPHIDAE
GORDIIDAE
HYDATICUS
HYDROBAENUS
HYDROCHARA
HYDROPORUS
HYDROPTILA
IRONOQUIA
ISOTOMIDAE
LIBELLULIDAE
LIMNEPHILIDAE
LIMNOPHYES
LIMNOPORUS
LUMBRICULIDAE
MENETUS
MICROVELIA
MOLANNODES
NAIDIDAE
NANOCLADIUS
NEMOURIDAE
OECETIS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
PALAEMONETES
PARACHAETOCLADIUS
PARACLADOPELMA
PARAKIEFFERIELLA
PARAMERINA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PARATANYTARSUS
PELTODYTES
PLACOBDELLA
PLATYCENTROPUS
POLYCENTROPUS
POLYPEDILUM
POTTHASTIA
PROCLADIUS
PROSIMULIUM
PROSTOIA
PROSTOMA
PSECTROCLADIUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PTILOSTOMIS
PYCNOPSYCHE
SCIRTIDAE
SIALIS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
STEGOPTERNA
STENELMIS
STICTOCHIRONOMUS
SYNURELLA
TABANIDAE
TANYPODINAE
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIBELOS
TUBIFICIDAE
TVETENIA
UNNIELLA
ZAVRELIMYIA

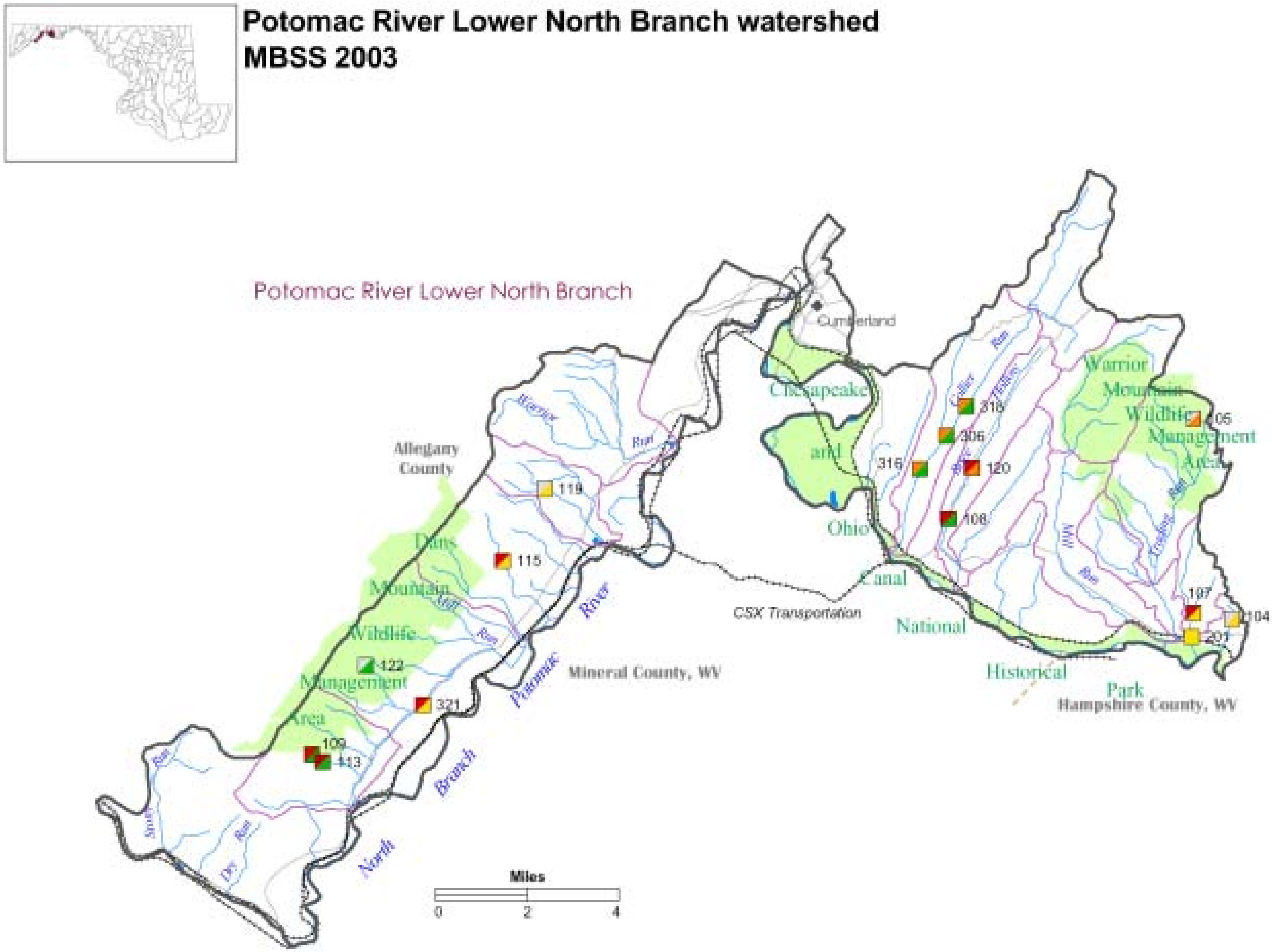
Herpetofauna Present
BULLFROG
COMMON SNAPPING TURTLE
EASTERN PAINTED TURTLE
FOWLER'S TOAD
GRAY TREEFROG
GREEN FROG
GROUND SKINK
SOUTHERN LEOPARD FROG
WOOD FROG

Pocomoke Sound/Tangier Sound/Big Annemessex River/Manokin River

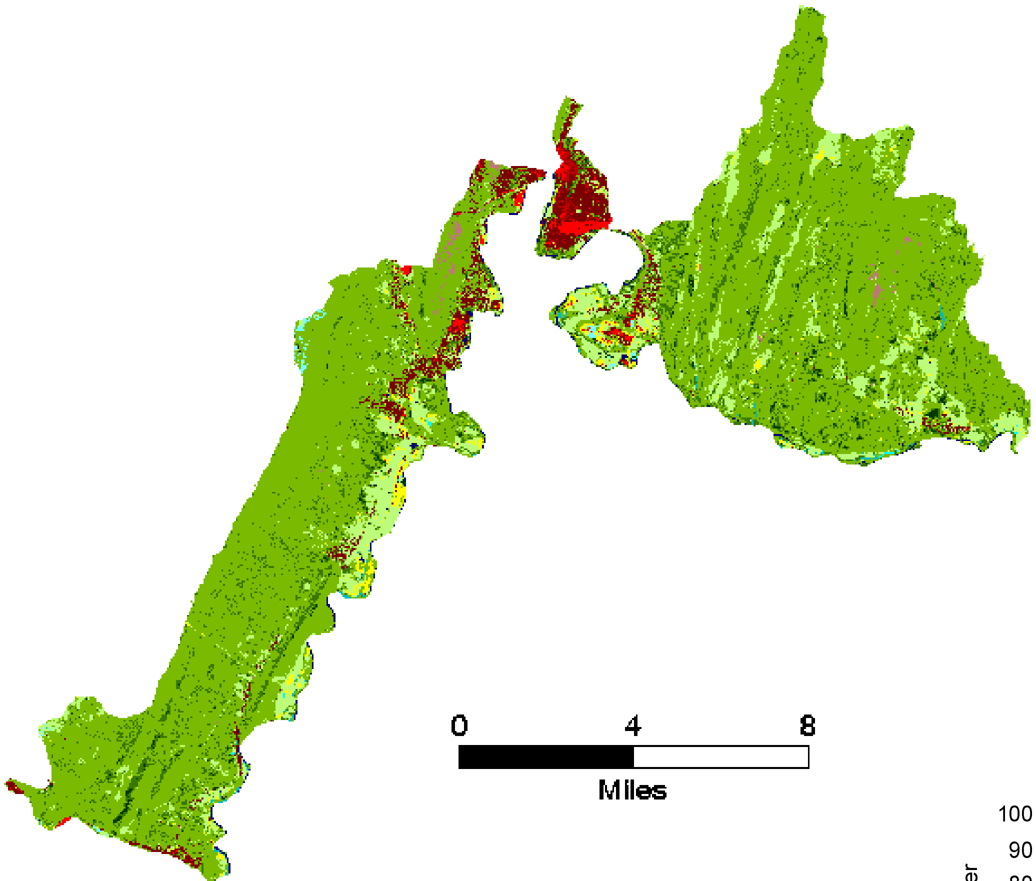
Stream Waders Data

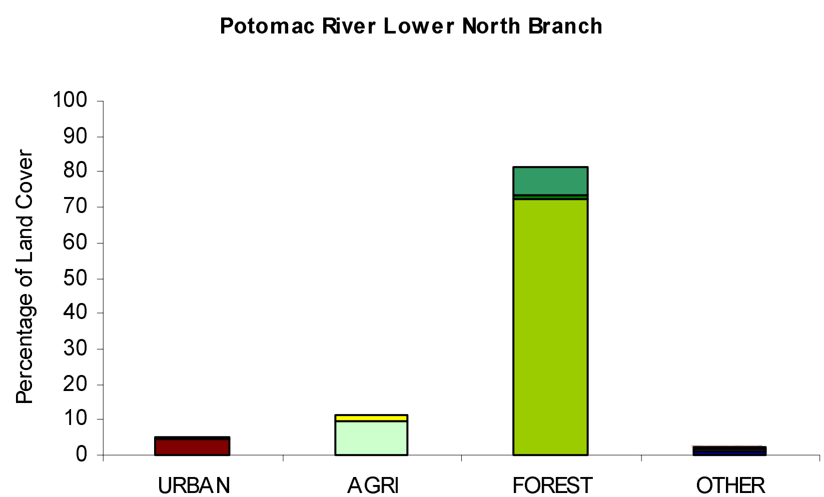
Site	8-digit Watershed	Stream Name	Benthic IBI
658-1-2003	Manokin River	Back Cr.	1.57
661-3-2003	Manokin River	Loretto Br.	1.57
661-2-2003	Manokin River	Manokin R.	1.29
661-1-2003	Manokin River	Manokin R.	1.29

Potomac River Lower North Branch watershed
MBSS 2003



Potomac River Lower North Branch





Potomac River Lower North Branch

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
PRLN-104-R-2003	POTOMAC R UT15	021410010072	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	12-Jun-03	1	144
PRLN-105-R-2003	TRADING RUN	021410010071	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	12-Jun-03	1	166
PRLN-107-R-2003	SEVEN SPRINGS RUN UT2 UT1	021410010073	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	26-Jun-03	1	400
PRLN-108-R-2003	BRICE HOLLOW RUN	021410010064	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	7-Jul-03	1	2281
PRLN-109-R-2003	TOMS HOLLOW CR	021410010054	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	26-Mar-03	18-Jun-03	1	464
PRLN-113-R-2003	TOMS HOLLOW CR	021410010054	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	26-Mar-03	18-Jun-03	1	609
PRLN-115-R-2003	POTOMAC R UT14	021410010056	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	26-Mar-03	7-Aug-03	1	847
PRLN-119-R-2003	POTOMAC R UT2 UT1	021410010057	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	27-Mar-03	18-Jun-03	1	210
PRLN-120-R-2003	BRICE HOLLOW RUN	021410010064	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	26-Jun-03	1	1784
PRLN-122-R-2003	MILL RUN (NO) UT2 UT1	021410010055	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	27-Mar-03	7-Aug-03	1	289
PRLN-201-R-2003	SEVEN SPRINGS RUN UT2	021410010073	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	25-Mar-03	26-Jun-03	2	1153
PRLN-306-R-2003	COLLIER RUN	021410010062	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	27-Mar-03	7-Jul-03	3	5708
PRLN-316-R-2003	COLLIER RUN	021410010062	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	27-Mar-03	7-Jul-03	3	6112
PRLN-318-R-2003	COLLIER RUN	021410010062	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	31-Mar-03	20-Aug-03	3	4624
PRLN-321-R-2003	MILL RUN (NO) UT2	021410010055	Potomac River (Lower North Branch	NORTH BRANCH POTOMAC RIVER	Allegany	26-Mar-03	17-Jul-03	3	5416

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
PRLN-104-R-2003	NR	3.22	84.3	0	0
PRLN-105-R-2003	NR	2.11	90.49	0	0
PRLN-107-R-2003	1.86	3.67	46.24	0	0
PRLN-108-R-2003	1.86	4.11	56.71	0	0
PRLN-109-R-2003	1.00	4.11	100	0	0
PRLN-113-R-2003	1.00	4.56	99.3	0	0
PRLN-115-R-2003	1.29	3.89	96.89	0	0
PRLN-119-R-2003	NR	3.22	79.72	0	0
PRLN-120-R-2003	1.57	2.78	77.33	0	0
PRLN-122-R-2003	NR	4.11	98.89	0	0
PRLN-201-R-2003	3.29	3.89	68.14	0	0
PRLN-306-R-2003	2.71	4.33	92.4	0	0
PRLN-316-R-2003	2.71	4.33	81.17	0	0
PRLN-318-R-2003	2.43	4.56	96.31	0	0
PRLN-321-R-2003	1.86	3.00	77.27	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
PRLN-104-R-2003	0.00	0.46	99.38	0.15	0.00
PRLN-105-R-2003	0.00	1.08	98.92	0.00	0.00
PRLN-107-R-2003	0.11	1.45	98.44	0.00	0.03
PRLN-108-R-2003	0.01	9.66	90.28	0.05	0.00
PRLN-109-R-2003	0.00	0.00	100.00	0.00	0.00
PRLN-113-R-2003	0.00	0.00	100.00	0.00	0.00
PRLN-115-R-2003	0.05	0.16	99.58	0.21	0.01
PRLN-119-R-2003	0.00	0.00	100.00	0.00	0.00
PRLN-120-R-2003	0.01	10.28	89.67	0.04	0.00
PRLN-122-R-2003	0.00	0.00	100.00	0.00	0.00
PRLN-201-R-2003	0.04	3.34	96.60	0.02	0.01
PRLN-306-R-2003	0.03	10.86	88.97	0.14	0.01
PRLN-316-R-2003	0.03	10.67	89.13	0.16	0.01
PRLN-318-R-2003	0.02	10.79	89.11	0.08	0.00
PRLN-321-R-2003	0.97	3.16	95.77	0.09	0.25
Overall PSU					

Potomac River Lower North Branch

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
PRLN-104-R-2003	6.09	66.4	85.1	1.588	0.136	19.632	0.0053	0.001	0.0004	0.004	0.211	1.952	7.40	0.80
PRLN-105-R-2003	5.40	46.9	11.0	1.147	0.225	13.880	0.0037	0.001	0.0004	0.006	0.344	2.797	7.10	0.50
PRLN-107-R-2003	6.81	67.1	189.3	1.509	0.137	16.409	0.0044	0.001	0.0004	0.002	0.197	1.361	8.60	2.20
PRLN-108-R-2003	7.31	100.4	367.1	5.435	0.420	16.873	0.0119	0.006	0.0004	0.005	0.561	2.666	8.50	2.10
PRLN-109-R-2003	7.51	90.3	353.3	1.120	1.568	17.498	0.0172	0.009	0.0004	0.003	1.683	1.089	10.10	3.20
PRLN-113-R-2003	7.53	91.0	355.0	1.130	1.557	17.468	0.0191	0.009	0.0004	0.004	1.663	1.627	10.10	3.20
PRLN-115-R-2003	7.07	61.4	125.1	1.490	1.470	13.233	0.0107	0.001	0.0004	0.003	1.554	1.404	7.70	2.80
PRLN-119-R-2003	6.80	58.2	115.5	1.291	1.266	13.102	0.0279	0.001	0.0004	0.004	1.327	0.843	9.60	5.90
PRLN-120-R-2003	7.05	86.2	230.0	5.258	0.503	15.514	0.0073	0.001	0.0004	0.007	0.666	2.940	8.00	3.10
PRLN-122-R-2003	6.75	49.4	65.7	1.044	1.017	12.151	0.0104	0.001	0.0004	0.003	1.051	0.447	8.40	2.10
PRLN-201-R-2003	6.69	68.0	163.5	2.336	0.153	16.367	0.0058	0.001	0.0004	0.002	0.217	1.490	8.10	2.70
PRLN-306-R-2003	7.35	77.7	226.5	5.325	0.364	14.487	0.0086	0.001	0.0004	0.003	0.451	1.853	8.70	1.30
PRLN-316-R-2003	7.11	80.5	264.9	5.156	0.368	14.617	0.0108	0.001	0.0004	0.005	0.423	1.850	8.20	3.50
PRLN-318-R-2003	7.23	91.0	229.9	9.002	0.291	14.599	0.0070	0.001	0.0004	0.002	0.388	1.882	8.70	1.00
PRLN-321-R-2003	7.18	77.3	223.2	3.720	0.755	15.321	0.0121	0.005	0.0004	0.004	0.850	1.441	8.00	6.30

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
PRLN-104-R-2003	50	50	FR	FR	6	11	8	7	34	10	41	35	93	16	28
PRLN-105-R-2003	50	50	FR	FR	7	15	6	6	16	10	40	40	97	20	28
PRLN-107-R-2003	0	0	DI	DI	12	8	11	12	31	8	58	35	93	11	56
PRLN-108-R-2003	10	50	PV	LN	10	11	10	8	42	10	33	35	50	16	36
PRLN-109-R-2003	50	50	FR	FR	18	19	10	9	7	19	75	15	98	20	47
PRLN-113-R-2003	50	50	FR	FR	18	19	10	10	9	19	75	15	98	20	42
PRLN-115-R-2003	50	50	FR	FR	12	16	7	10	29	10	62	20	95	20	40
PRLN-119-R-2003	50	50	FR	FR	14	13	9	10	20	15	55	25	92	14	32
PRLN-120-R-2003	50	50	FR	FR	16	13	11	13	36	16	41	30	88	19	51
PRLN-122-R-2003	50	50	FR	FR	15	17	10	10	31	15	50	30	99	20	43
PRLN-201-R-2003	50	50	FR	FR	11	11	11	12	51	11	25	35	85	15	58
PRLN-306-R-2003	50	50	FR	FR	12	13	10	9	38	13	45	25	94	20	32
PRLN-316-R-2003	50	50	FR	FR	13	12	13	14	63	12	32	35	40	16	52
PRLN-318-R-2003	50	50	FR	FR	16	17	11	14	50	13	41	20	94	18	68
PRLN-321-R-2003	50	50	FR	LN	12	13	9	9	18	16	60	40	91	8	36

Potomac River Lower North Branch

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
PRLN-104-R-2003	N	N	N	N	Moderate	Moderate	Moderate
PRLN-105-R-2003	N	N	N	N	None	None	None
PRLN-107-R-2003	Y	N	N	Y	Moderate	Mild	Moderate
PRLN-108-R-2003	Y	N	N	Y	None	None	Moderate
PRLN-109-R-2003	N	N	N	N	None	None	None
PRLN-113-R-2003	N	N	N	N	None	None	None
PRLN-115-R-2003	N	N	N	N	None	None	Minor
PRLN-119-R-2003	N	N	N	N	Mild	None	None
PRLN-120-R-2003	N	N	N	N	Mild	Mild	Minor
PRLN-122-R-2003	N	Y	Y	N	None	None	Minor
PRLN-201-R-2003	N	N	N	Y	Mild	None	Moderate
PRLN-306-R-2003	N	N	N	N	Mild	Mild	Extensive
PRLN-316-R-2003	N	N	N	N	None	None	Moderate
PRLN-318-R-2003	N	N	N	N	Mild	None	Moderate
PRLN-321-R-2003	N	N	N	Y	Mild	Mild	Minor

Summary of Watershed Condition

- ANC low at seven sites
- Nitrogen and phosphorus elevated at some sites
- Physical habitat parameters generally good

Potomac River Lower North Branch

Fish Species Present
BLACKNOSE DACE
BLUE RIDGE SCULPIN
CENTRAL STONEROLLER
CREEK CHUB
CREEK CHUBSUCKER
FANTAIL DARTER
GREEN SUNFISH
POTOMAC SCULPIN
PUMPKINSEED
RAINBOW DARTER
RAINBOW TROUT
ROSYSIDE DACE
WHITE SUCKER

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM

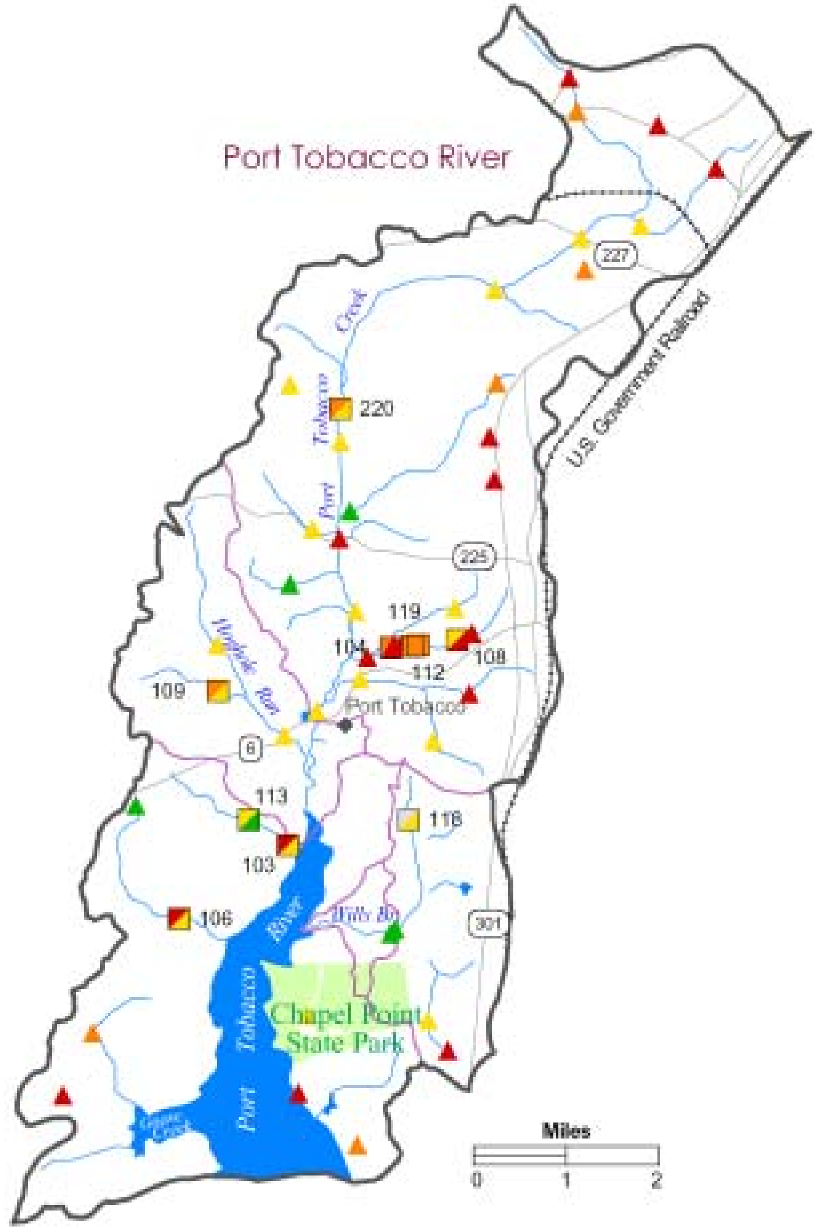
Benthic Taxa Present
ACRONEURIA
AESHNIDAE
AMELETUS
AMPHINEMURA
ANTOCHA
BAETIDAE
BOYERIA
BRILLIA
CAECIDOTEA
CAENIS
CAMBARIDAE
CAMBARUS
CAPNIIDAE
CERATOPOGON
CHAETOCLADIUS
CHELIFERA
CHEUMATOPSYCHE
CHIMARRA
CHLOROPERLIDAE
CLIOPERLA
CORYNONEURA
CRANGONYX
DIAMESA
DIAMESINAE
DICRANOTA
DIPLECTRONA
DOLOPHILODES
DRUNELLA
ECTOPRIA
ELMIDAE
ENCHYTRAEIDAE
ENDOCHIRONOMUS
EPEORUS
EPHEMERA
EPHEMERELLA
EPHEMERELLIDAE
EUKIEFFERIELLA
EURYLOPHELLA
GOMPHIDAE
HELENIELLA
HEPTAGENIIDAE
HEXATOMA
HYDROPHILIDAE
HYDROPORUS
HYDROPSYCHE
ISOPERLA
LEPIDOSTOMA
LEPTOPHLEBIIDAE
LEUCTRA
LEUCTRIDAE
LIMNEPHILIDAE
LUMBRICULIDAE
MICROPSECTRA
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORTHOCLADIUS
OSTROCERCA
OULIMNIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PELTOPERLIDAE
PERLIDAE
PERLODIDAE
PHILOPOTAMIDAE
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PSEPHENUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PTERONARCYS
PYCNOPSYCHE
RHEOCRICOTOPUS
RHYACOPHILA
SPHAERIIDAE
STEGOPTERNA
STEMPELLINELLA
STENACRON
STENELMIS
STENONEMA
SWELTSA
SYMPOTTHASTIA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TVETENIA
WORMALDIA
YUGUS

Herpetofauna Present
BULLFROG
EASTERN BOX TURTLE
GREEN FROG
NORTHERN DUSKY SALAMANDER
NORTHERN SLIMY SALAMANDER
NORTHERN SPRING SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
RED SALAMANDER
SEAL SALAMANDER
WOOD TURTLE

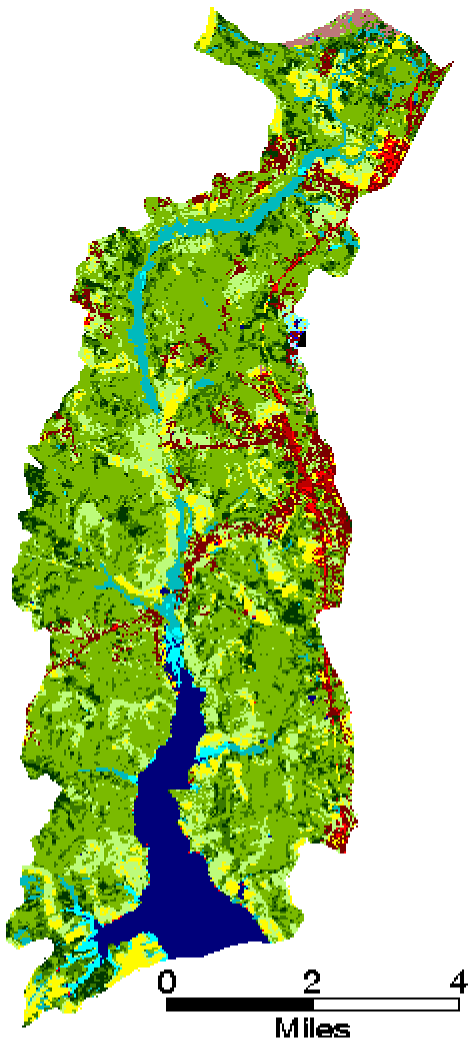
Stream Waders Data

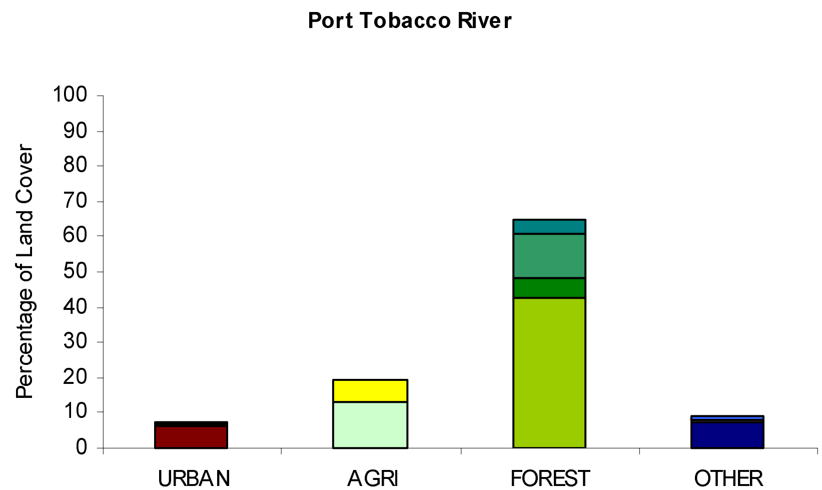
No Stream Waders data collected in 2003

Port Tobacco River watershed
MBSS 2003



Port Tobacco River





Port Tobacco River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
PTOB-103-R-2003	PORT TOBACCO R UT2	021401090770	Port Tobacco River	LOWER POTOMAC RIVER	Charles	18-Mar-03	26-Jun-03	1	514
PTOB-104-R-2003	PORT TOBACCO CR UT1	021401090774	Port Tobacco River	LOWER POTOMAC RIVER	Charles	20-Mar-03	30-Jun-03	1	567
PTOB-106-R-2003	PORT TOBACCO R UT1	021401090770	Port Tobacco River	LOWER POTOMAC RIVER	Charles	18-Mar-03	26-Jun-03	1	1241
PTOB-108-R-2003	PORT TOBACCO CR UT1	021401090774	Port Tobacco River	LOWER POTOMAC RIVER	Charles	31-Mar-03	1-Jul-03	1	417
PTOB-109-R-2003	HOGHOLE RUN UT1	021401090773	Port Tobacco River	LOWER POTOMAC RIVER	Charles	18-Mar-03	24-Jun-03	1	582
PTOB-112-R-2003	PORT TOBACCO CR UT1	021401090774	Port Tobacco River	LOWER POTOMAC RIVER	Charles	20-Mar-03	30-Jun-03	1	533
PTOB-113-R-2003	PORT TOBACCO R UT2	021401090770	Port Tobacco River	LOWER POTOMAC RIVER	Charles	31-Mar-03	8-Jul-03	1	357
PTOB-118-R-2003	WILLS BR	021401090771	Port Tobacco River	LOWER POTOMAC RIVER	Charles	18-Mar-03	8-Jul-03	1	141
PTOB-119-R-2003	PORT TOBACCO CR UT1	021401090774	Port Tobacco River	LOWER POTOMAC RIVER	Charles	31-Mar-03	30-Jun-03	1	542
PTOB-220-R-2003	PORT TOBACCO CR	021401090774	Port Tobacco River	LOWER POTOMAC RIVER	Charles	20-Mar-03	17-Jul-03	2	6779

Indicator Information

Site	IBI	IBI	PHI	rook Trout Present	kwater Stream
B-103-R-2003	1.75	3.86	69.69	0	0
B-104-R-2003	2.75	1.86	72.98	0	0
B-106-R-2003	1.50	3.00	77.46	0	0
B-108-R-2003	3.25	1.57	50.22	0	0
B-109-R-2003	2.50	3.29	84.41	0	0
B-112-R-2003	2.75	2.14	78.03	0	0
B-113-R-2003	3.00	4.43	76.56	0	0
B-118-R-2003	NR	3.00	72.81	0	0
B-119-R-2003	2.75	2.71	70.69	0	0
B-220-R-2003	2.50	3.00	84.69	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
PTOB-103-R-2003	5.60	8.60	85.66	0.13	1.49
PTOB-104-R-2003	43.47	12.00	43.82	0.71	17.43
PTOB-106-R-2003	3.00	16.72	80.20	0.07	0.80
PTOB-108-R-2003	49.87	11.00	38.17	0.96	20.58
PTOB-109-R-2003	1.46	10.31	87.97	0.27	0.36
PTOB-112-R-2003	44.94	11.75	42.56	0.75	17.80
PTOB-113-R-2003	7.88	4.82	87.11	0.19	2.10
PTOB-118-R-2003	1.91	10.65	86.49	0.95	0.64
PTOB-119-R-2003	44.25	12.07	42.94	0.74	17.51
PTOB-220-R-2003	10.05	11.88	70.78	7.30	3.15

Interpretation of Watershed Condition

- Four sites in urban catchments
- ANC low at six sites
- Chloride and nitrogen elevated at same four sites with high urban land use
- Phosphorus elevated throughout
- Physical habitat parameters generally good

Port Tobacco River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (µeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
PTOB-103-R-2003	6.35	127.6	67.7	20.706	0.483	19.803	0.0290	0.015	0.0004	0.005	0.620	2.089	8.70	5.20
PTOB-104-R-2003	7.20	306.9	914.3	42.162	1.980	29.082	0.5168	0.017	0.0360	1.164	3.731	5.074	7.80	7.10
PTOB-106-R-2003	6.29	91.3	60.0	9.448	0.286	21.358	0.0312	0.015	0.0004	0.007	0.417	2.110	8.80	4.10
PTOB-108-R-2003	7.33	414.7	1234.4	61.039	2.339	38.859	0.1112	0.016	0.0703	1.024	3.727	3.582	7.30	7.10
PTOB-109-R-2003	6.32	41.5	39.0	3.220	0.010	10.090	0.0377	0.014	0.0004	0.004	0.105	2.699	8.90	4.30
PTOB-112-R-2003	7.09	319.4	744.9	56.475	1.502	22.723	0.4443	0.022	0.0285	0.895	2.924	5.957	7.60	8.60
PTOB-113-R-2003	6.37	132.3	81.6	25.285	0.341	13.845	0.0485	0.022	0.0044	0.007	0.502	3.226	8.20	4.10
PTOB-118-R-2003	5.45	95.3	18.8	20.247	0.009	9.969	0.0121	0.005	0.0004	0.004	0.098	2.315	7.80	3.40
PTOB-119-R-2003	7.31	379.2	1099.7	53.743	2.172	35.626	0.0856	0.022	0.0557	1.002	3.558	4.041	7.60	8.60
PTOB-220-R-2003	6.28	149.6	64.3	29.834	0.523	16.401	0.0275	0.005	0.0004	0.010	0.740	3.838	7.30	15.40

Physical Habitat Condition

Site	Riparian Buffer Width Left	Riparian Buffer Width Right	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	Embed-dedness	Shading	Trash Rating	Maximum Depth (cm)
PTOB-103-R-2003	50	50	FR	FR	7	9	6	6	12	12	75	40	95	13	31
PTOB-104-R-2003	50	50	FR	HO	15	12	13	13	36	10	45	15	90	7	68
PTOB-106-R-2003	50	50	FR	FR	13	13	10	10	25	13	65	35	75	17	43
PTOB-108-R-2003	50	50	LN	LN	8	7	11	11	50	11	43	40	85	5	56
PTOB-109-R-2003	50	50	FR	FR	13	16	12	11	42	13	33	20	90	18	51
PTOB-112-R-2003	50	50	FR	LO	15	10	9	9	48	12	33	20	60	10	44
PTOB-113-R-2003	50	50	FR	OF	11	11	8	8	14	13	65	40	95	13	29
PTOB-118-R-2003	50	50	FR	HO	7	15	8	6	37	6	38	15	95	18	41
PTOB-119-R-2003	50	50	FR	LN	13	10	9	10	37	12	43	20	65	10	48
PTOB-220-R-2003	50	50	FR	FR	18	16	14	15	50	9	25	35	95	18	122

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
PTOB-103-R-2003	N	N	N	N	None	None	None
PTOB-104-R-2003	N	N	N	N	Moderate	Moderate	Extensive
PTOB-106-R-2003	N	N	N	N	Moderate	Moderate	Moderate
PTOB-108-R-2003	Y	N	N	N	Severe	Severe	Moderate
PTOB-109-R-2003	N	N	N	N	Mild	Mild	Extensive
PTOB-112-R-2003	N	N	N	N	Moderate	Severe	Moderate
PTOB-113-R-2003	N	N	N	N	Mild	Moderate	Minor
PTOB-118-R-2003	N	N	N	N	Severe	Moderate	Extensive
PTOB-119-R-2003	N	N	N	N	Moderate	Moderate	Moderate
PTOB-220-R-2003	N	N	N	N	Mild	Mild	Moderate

Port Tobacco River

Fish Species Present
AMERICAN EEL
BANDED KILLIFISH
BLACKNOSE DACE
BLUEGILL
CREEK CHUB
CREEK CHUBSUCKER
EASTERN MUDMINNOW
LARGEMOUTH BASS
MOSQUITOFISH
PUMPKINSEED
REDBREAST SUNFISH
ROSYSIDE DACE
SWALLOWTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present
MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM
BAMBOO

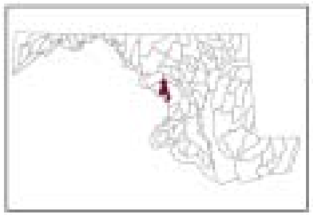
Benthic Taxa Present
ACERPENNA
ALLOCAPNIA
AMELETUS
AMPHINEMURA
CAECIDOTEA
CALOPTERYX
CAPNIIDAE
CERATOPOGON
CERATOPOGONIDAE
CHAETOCLADIUS
CHEUMATOPSYCHE
CHIRONOMINI
CHLOROPERLIDAE
CHRYSOGASTER
CLIOPERLA
COLLEMBOLA
CONCHAPELOPIA
COPELATUS
CORYNONEURA
CRANGONYX
CRICOTOPUS
CURA
DIAMESA
DIPLECTRONA
DIPLOCLADIUS
DIPTERA
DOLICHOPODIDAE
DOLOPHILODES
DYTISCIDAE
ENCHYTRAEIDAE
EPHEMERELLA
ERPOBDELLIDAE
EUKIEFFERIELLA
HYDROBAENUS
HYDROPSYCHE
HYDROPSYCHIDAE
IRONOQUIA
ISOPERLA
LEPIDOSTOMA
LEPTOPHLEBIA
LEUCTRA
LIMNEPHILIDAE
LUMBRICULIDAE
MICROTENDIPES
MOLOPHILUS
MOOREOBDELLA
NAIDIDAE
NEMOURIDAE
NEOPHYLAX
NIGRONIA
OEMOPTERYX
OPTIOSERVUS
ORMOSIA
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PERLODIDAE
PHYSELLA
POLYPEDILUM
PROMENETUS
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PYCNOPSYCHE
RHEOTANYTARSUS
RHYACOPHILA
SIMULIUM
SPHAERIIDAE
STAGNICOLA
STEGOPTERNA
STENELMIS
STENONEMA
SYMPOTTHASTIA
SYNURELLA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRISSOPELOPIA
TUBIFICIDAE
ZAVRELIMYIA

Herpetofauna Present
AMERICAN TOAD
BULLFROG
COMMON MUSK TURTLE
EASTERN BOX TURTLE
EASTERN BOX TURTLE
EASTERN SPADEFOOT TOAD
FOWLER'S TOAD
GREEN FROG
NORTHERN BLACK RACER
NORTHERN COPPERHEAD
NORTHERN RINGNECK SNAKE
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
RED SALAMANDER
SOUTHERN LEOPARD FROG
SPOTTED SALAMANDER
WOOD FROG

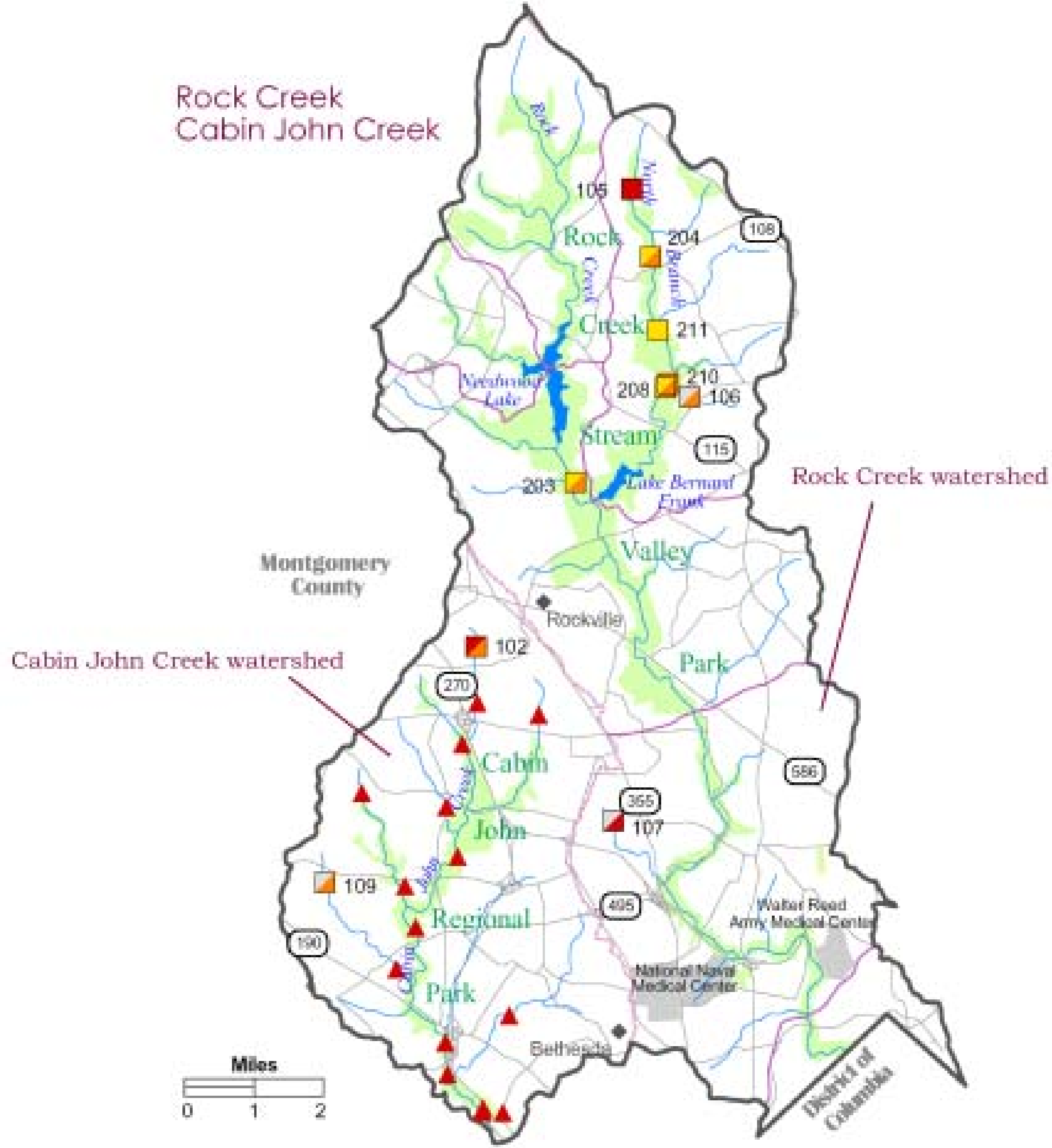
Port Tobacco River

Stream Waders Data

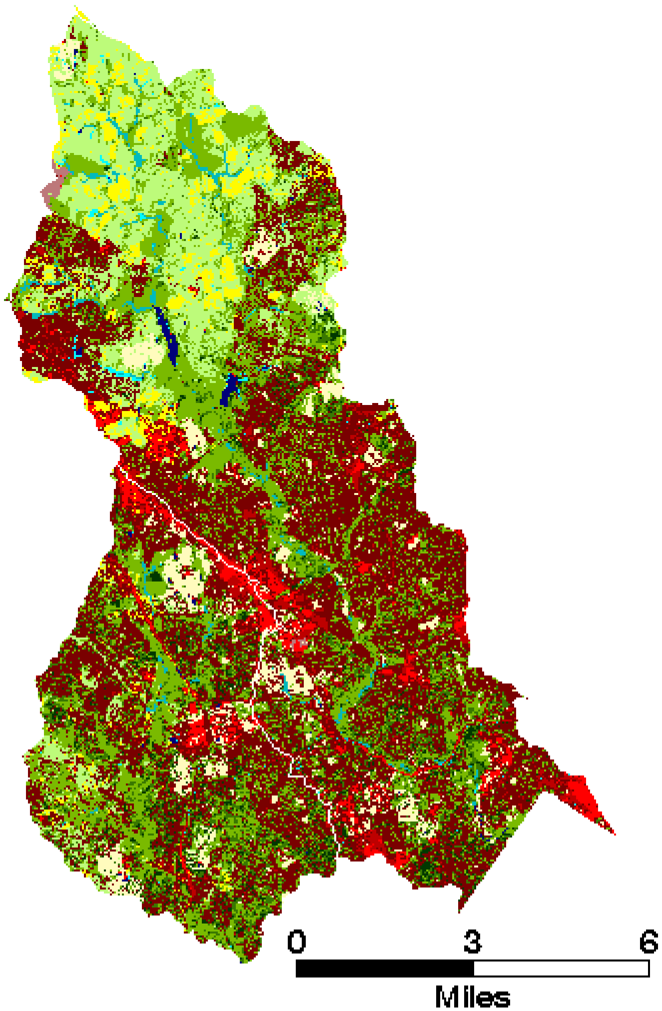
Site	8-digit Watershed	Stream Name	Benthic IBI
773-1-2003	Port Tobacco River	Hog Holr Run	3.29
773-2-2003	Port Tobacco River	Hoghole Run	3.57
774-12-2003	Port Tobacco River	Jennie Run	2.71
774-15-2003	Port Tobacco River	Jennie Run	4.43
774-11-2003	Port Tobacco River	Jennie Run UT	1.29
774-10-2003	Port Tobacco River	Jennie Run UT	1.86
774-4-2003	Port Tobacco River	Pages Swamp	3.00
774-5-2003	Port Tobacco River	Pages Swamp	3.57
774-6-2003	Port Tobacco River	Pages Swamp	3.86
774-0-2003	Port Tobacco River	Pages Swamp UT	1.29
774-3-2003	Port Tobacco River	Pages Swamp UT	1.29
774-1-2003	Port Tobacco River	Pages Swamp UT	1.57
774-2-2003	Port Tobacco River	Pages Swamp UT	2.14
774-7-2003	Port Tobacco River	Pages Swamp UT	2.71
774-17-2003	Port Tobacco River	Port Tobacco Cr.	1.86
774-9-2003	Port Tobacco River	Port Tobacco Cr.	3.29
774-29-2003	Port Tobacco River	Port Tobacco Cr.	3.00
774-20-2003	Port Tobacco River	Port Tobacco Cr.	3.29
774-19-2003	Port Tobacco River	Port Tobacco Cr.	3.57
774-24-2003	Port Tobacco River	Port Tobacco Cr. UT	1.00
774-27-2003	Port Tobacco River	Port Tobacco Cr. UT	1.29
774-26-2003	Port Tobacco River	Port Tobacco Cr. UT	1.00
774-25-2003	Port Tobacco River	Port Tobacco Cr. UT	1.29
774-8-2003	Port Tobacco River	Port Tobacco Cr. UT	3.00
774-23-2003	Port Tobacco River	Port Tobacco Cr. UT	3.57
774-16-2003	Port Tobacco River	Port Tobacco Cr. UT	3.86
774-28-2003	Port Tobacco River	Port Tobacco Cr. UT	3.86
774-18-2003	Port Tobacco River	Port Tobacco Cr. UT	4.14
770-4-2003	Port Tobacco River	Port Tobacco R. UT	1.29
770-5-2003	Port Tobacco River	Port Tobacco R. UT	1.57
770-2-2003	Port Tobacco River	Port Tobacco R. UT	2.71
770-7-2003	Port Tobacco River	Port Tobacco R. UT	2.71
770-8-2003	Port Tobacco River	Port Tobacco R. UT	3.29
770-1-2003	Port Tobacco River	Port Tobacco R. UT	4.71
771-1-2003	Port Tobacco River	Wills Br.	1.00
772-1-2003	Port Tobacco River	Wills Br.	4.14
771-2-2003	Port Tobacco River	Wills Br.	3.86
771-3-2003	Port Tobacco River	Wills Br.	4.14

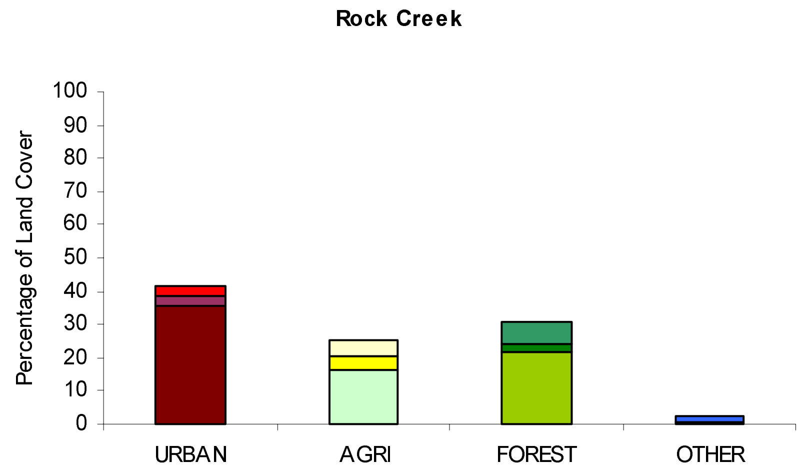


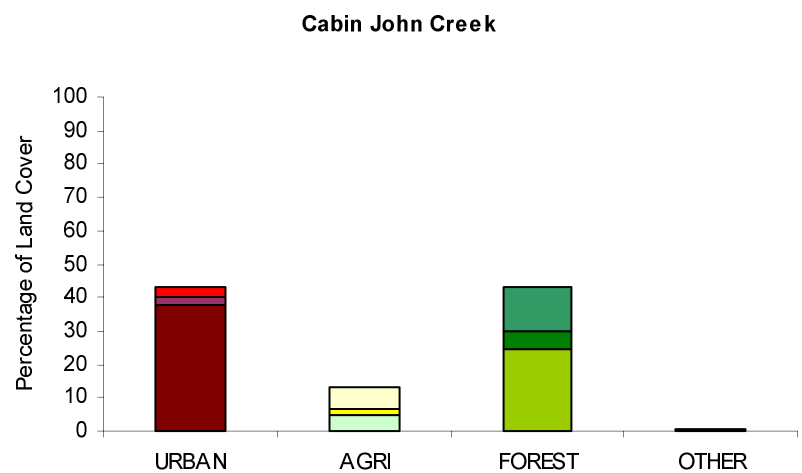
Rock Creek/
Cabin John Creek watersheds
MBSS 2003



Rock Creek/Cabin John Creek







Rock Creek/Cabin John Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
CABJ-102-R-2003	CABIN JOHN CR	021402070841	Cabin John Creek	WASHINGTON METRO	Montgomery	3-Apr-03	17-Jun-03	1	588
CABJ-109-R-2003	CABIN JOHN CR UT1	021402070841	Cabin John Creek	WASHINGTON METRO	Montgomery	3-Apr-03	17-Jun-03	1	244
ROCK-105-R-2003	NORTH BR ROCK CR	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	16-Jun-03	1	579
ROCK-106-R-2003	NORTH BR ROCK CR UT1	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	16-Jun-03	1	283
ROCK-107-R-2003	ROCK CR UT2	021402060836	Rock Creek	WASHINGTON METRO	Montgomery	3-Apr-03	17-Jun-03	1	193
ROCK-203-R-2003	ROCK CR	021402060837	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	16-Jul-03	2	2251
ROCK-204-R-2003	NORHT BR ROCK CR	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	16-Jun-03	2	1872
ROCK-208-R-2003	NORTH BR ROCK CR	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	15-Jul-03	2	5645
ROCK-210-R-2003	NORTH BR ROCK CR	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	15-Jul-03	2	5618
ROCK-211-R-2003	NORTH BR ROCK CR	021402060838	Rock Creek	WASHINGTON METRO	Montgomery	2-Apr-03	16-Jul-03	2	4107

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
CABJ-102-R-2003	1.89	2.33	56.44	0	0
CABJ-109-R-2003	NR	2.11	52.88	0	0
ROCK-105-R-2003	1.67	1.89	75.1	0	0
ROCK-106-R-2003	NR	2.56	66.76	0	0
ROCK-107-R-2003	NR	1.67	50.7	0	0
ROCK-203-R-2003	3.67	2.33	62.4	0	0
ROCK-204-R-2003	3.44	2.56	79.2	0	0
ROCK-208-R-2003	3.00	2.33	76.62	0	0
ROCK-210-R-2003	2.78	2.56	82.97	0	0
ROCK-211-R-2003	3.00	3.00	88.7	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
CABJ-102-R-2003	73.03	5.86	20.35	0.76	30.68
CABJ-109-R-2003	26.23	27.05	44.99	1.73	7.19
ROCK-105-R-2003	1.50	64.64	33.21	0.65	0.49
ROCK-106-R-2003	7.41	49.17	41.92	1.50	2.48
ROCK-107-R-2003	39.15	40.64	20.09	0.11	27.24
ROCK-203-R-2003	35.36	37.64	20.76	6.24	10.80
ROCK-204-R-2003	1.49	54.81	43.37	0.33	0.41
ROCK-208-R-2003	19.32	45.55	34.73	0.40	5.63
ROCK-210-R-2003	19.30	45.65	34.64	0.40	5.63
ROCK-211-R-2003	16.12	49.87	33.68	0.33	4.60
Overall PSU					

Summary of Watershed Condition

- Four sites in highly urban catchments; chloride elevated at those sites
- Nitrogen and phosphorus elevated throughout
- Physical habitat parameters generally good
- Evidence of channelization at four sites

Rock Creek/Cabin John Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
CABJ-102-R-2003	7.82	629.1	933.6	144.064	3.433	22.622	0.0350	0.005	0.0096	0.004	3.472	1.522	8.00	1.60
CABJ-109-R-2003	7.81	384.1	1812.1	51.059	0.412	36.910	0.0162	0.001	0.0030	0.008	0.593	3.285	8.40	2.30
ROCK-105-R-2003	7.02	99.3	305.9	14.982	1.062	4.234	0.0236	0.002	0.0033	0.007	1.244	3.994	8.60	7.30
ROCK-106-R-2003	8.59	169.4	912.6	17.478	0.497	10.576	0.0325	0.001	0.0040	0.006	0.729	3.014	10.50	2.40
ROCK-107-R-2003	7.24	387.1	1963.1	48.888	1.553	28.182	0.0236	0.006	0.0033	0.004	1.602	1.118	8.10	4.10
ROCK-203-R-2003	7.24	312.9	936.1	55.737	1.419	12.752	0.1067	0.029	0.0247	0.585	2.137	3.869	6.80	7.70
ROCK-204-R-2003	7.19	125.3	474.6	17.199	1.724	5.848	0.0221	0.004	0.0038	0.008	1.813	2.647	8.30	6.20
ROCK-208-R-2003	7.44	161.2	624.2	19.949	1.659	9.169	0.0198	0.003	0.0046	0.005	1.731	2.510	8.00	8.60
ROCK-210-R-2003	7.53	160.1	613.9	19.999	1.636	9.114	0.0190	0.001	0.0043	0.004	1.752	2.310	7.80	8.80
ROCK-211-R-2003	7.53	153.3	550.0	20.073	1.753	8.595	0.0257	0.002	0.0049	0.007	1.895	2.332	7.60	8.70

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed- dedness	% Shading	Trash Rating	Maximum Depth (cm)
CABJ-102-R-2003	40	40	PV	PV	10	11	11	12	54	12	23	35	70	3	57
CABJ-109-R-2003	30	50	HO	LN	9	11	8	9	48	8	30	35	92	12	49
ROCK-105-R-2003	50	50	FR	FR	15	16	15	17	58	11	22	22	97	17	88
ROCK-106-R-2003	50	45	OF	HO	11	15	12	11	33	10	46	30	95	10	55
ROCK-107-R-2003	5	5	PK	PK	7	5	6	7	38	11	37	30	95	2	26
ROCK-203-R-2003	50	15	FR	PV	16	12	14	16	50	13	28	36	84	5	87
ROCK-204-R-2003	50	50	FR	FR	17	16	15	15	30	16	55	20	95	14	81
ROCK-208-R-2003	50	50	FR	FR	17	14	15	17	50	13	25	27	85	10	210
ROCK-210-R-2003	50	50	FR	FR	18	17	16	15	48	16	43	22	88	4	68
ROCK-211-R-2003	50	50	FR	LN	18	17	16	15	55	16	26	18	86	16	72
CATO-103-R-2003	38	50	CP	LN	9	7	11	11	55	13	22	40	90	18	51

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
CABJ-102-R-2003	N	N	N	Y	Moderate	Mild	Moderate
CABJ-109-R-2003	Y	N	N	N	Moderate	Moderate	Extensive
ROCK-105-R-2003	N	N	N	N	Severe	Mild	Moderate
ROCK-106-R-2003	N	N	N	N	Mild	Moderate	Extensive
ROCK-107-R-2003	Y	N	N	Y	Mild	Moderate	Minor
ROCK-203-R-2003	Y	N	N	Y	Mild	Mild	Moderate
ROCK-204-R-2003	N	N	N	N	Mild	Moderate	Moderate
ROCK-208-R-2003	N	N	N	N	Severe	Severe	Extensive
ROCK-210-R-2003	N	N	N	N	Moderate	Moderate	Minor
ROCK-211-R-2003	N	N	N	Y	Moderate	Mild	Minor

Rock Creek/Cabin John Creek

Fish Species Present
AMERICAN EEL
BLACK CRAPPIE
BLACKNOSE DACE
BLUEGILL
BLUNTNOSE MINNOW
BROWN BULLHEAD
CREEK CHUB
CUTLIPS MINNOW
FALLFISH
GREEN SUNFISH
LARGEMOUTH BASS
LONGNOSE DACE
MARGINED MADTOM
NORTHERN HOGSUCKER
POTOMAC SCULPIN
PUMPKINSEED
REDBREAST SUNFISH
ROSYSIDE DACE
SATINFIN SHINER
SILVERJAW MINNOW
SPOTTAIL SHINER
SWALLOWTAIL SHINER
TESSELLATED DARTER
WHITE SUCKER
YELLOW BULLHEAD

Exotic Plants Present
MULTIFLORA ROSE
MILE-A-MINUTE
JAPANESE HONEYSUCKLE
THISTLE
MICROSTEGIUM
JAPANESE KNOTWEED

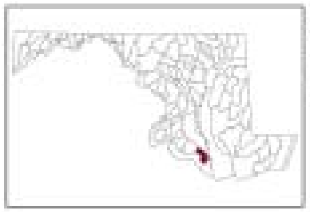
Benthic Taxa Present
AMELETUS
AMPHINEMURA
BRACONIDAE
CAECIDOTEA
CAMBARUS
CERATOPOGONIDAE
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMINAE
CLIOPERLA
COENAGRIONIDAE
CORBICULA
CORYDALUS
CRANGONYX
CRICOTOPUS
CRYPTOCHIRONOMUS
DIAMESA
DICROTENDIPES
DIPLECTRONA
DIPLOCLADIUS
DUGESIA
EMPIDIDAE
ENCHYTRAEIDAE
EPHEMERELLA
EUKIEFFERIELLA
EURYLOPHELLA
GASTROPODA
GOMPHIDAE
GORDIIDAE
HEMERODROMIA
HIRUDINEA
HYDROBAENUS
HYDROPSYCHE
ISOPERLA
LEUCTRIDAE
LIMONIA
LUMBRICULIDAE
MACRONYCHUS
MEROPELOPIA
MICROTENDIPES
NAIDIDAE
NEOPHYLAX
NIGRONIA
NOCTUIDAE
OPTIOSERVUS
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PERLODIDAE
PHYSELLA
PISIDIUM
PLANORBIDAE
POLYPEDILUM
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEUDORTHOCLADIUS
PSYCHODA
RHEOCRICOTOPUS
RHEOTANYTARSUS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
SPIROSPERMA
STAGNICOLA
STEGOPTERNA
STENELMIS
STENONEMA
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present
AMERICAN TOAD
BULLFROG
EASTERN BOX TURTLE
EASTERN GARTER SNAKE
FIVE-LINED SKINK
GREEN FROG
NORTHERN RINGNECK SNAKE
NORTHERN SPRING PEEPER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
RED SALAMANDER
SPOTTED SALAMANDER
WOOD FROG

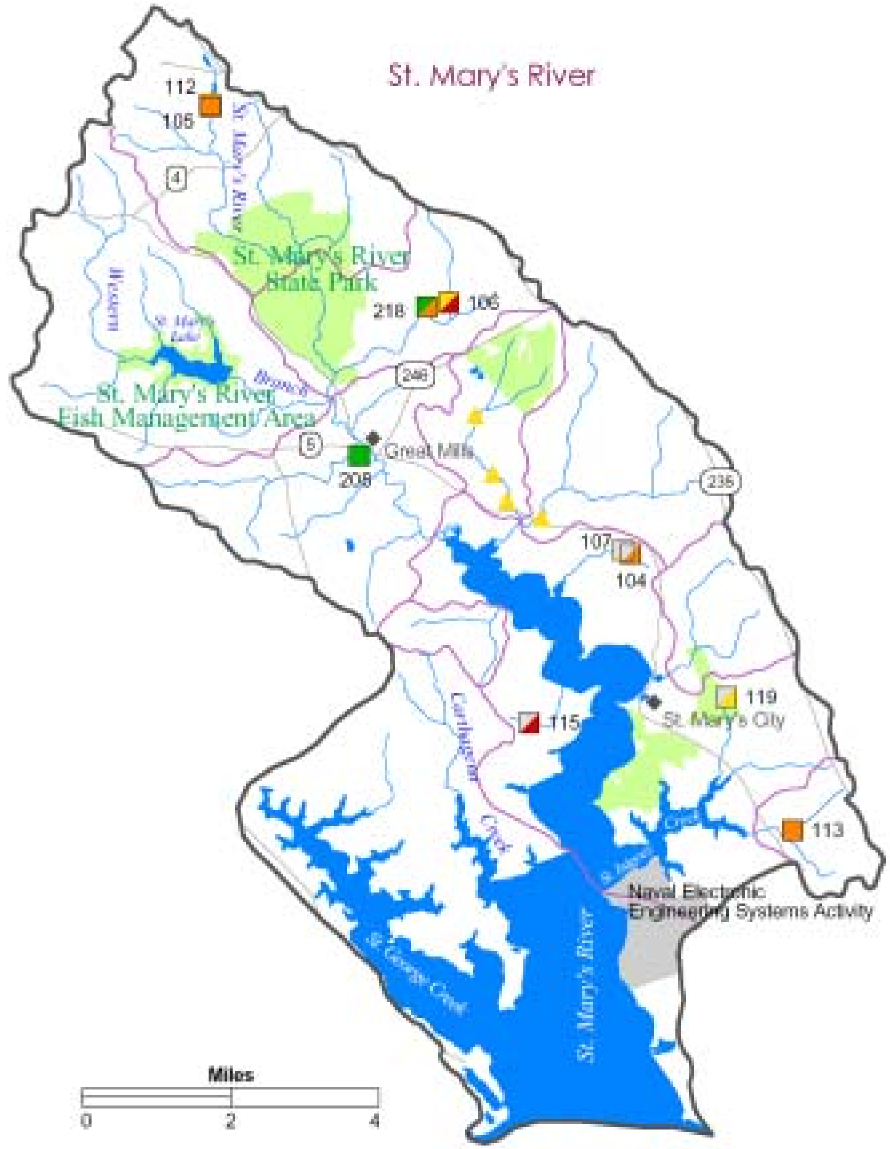
Rock Creek/Cabin John Creek

Stream Waders Data

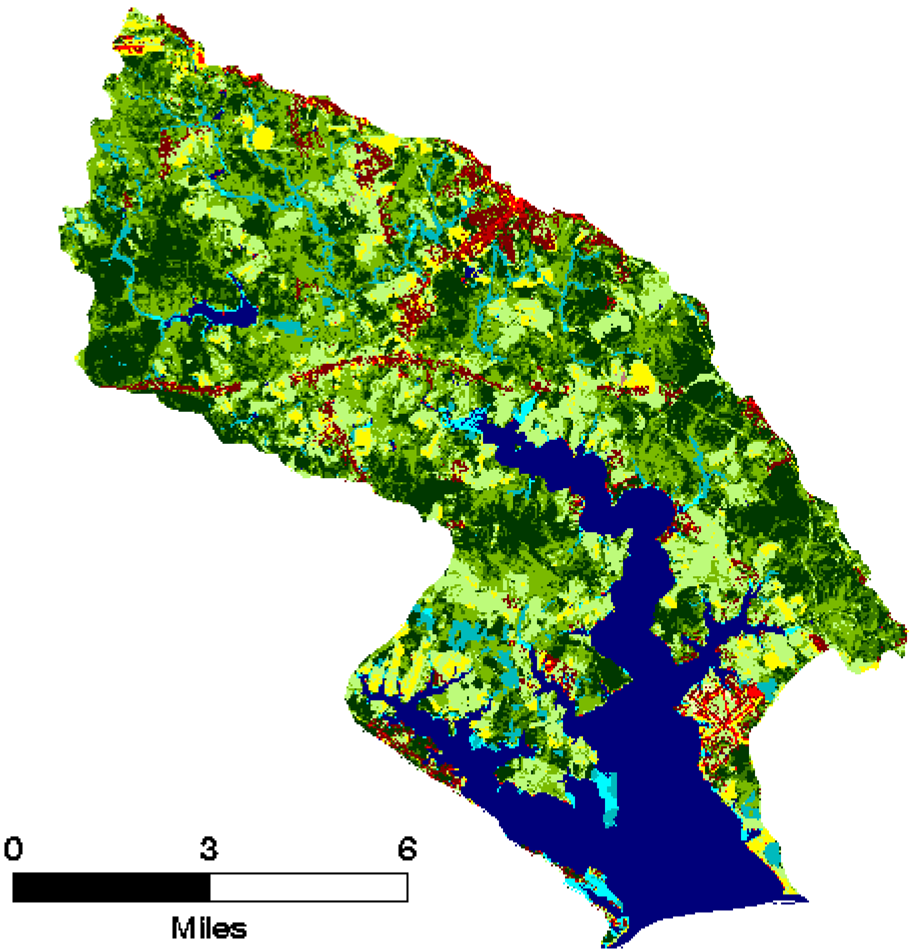
Site	8-digit Watershed	Stream Name	Benthic IBI
841-8-2003	Cabin John Creek	Bannockburn Br.	1.29
841-16-2003	Cabin John Creek	Booze Cr.	1.00
841-14-2003	Cabin John Creek	Buck Br.	1.00
841-3-2003	Cabin John Creek	Buck Br.	1.29
841-2-2003	Cabin John Creek	Cabin John Cr.	1.29
841-4-2003	Cabin John Creek	Cabin John Cr.	1.29
841-6-2003	Cabin John Creek	Cabin John Cr.	1.29
841-9-2003	Cabin John Creek	Cabin John Cr.	1.29
841-11-2003	Cabin John Creek	Cabin John Cr.	1.29
841-7-2003	Cabin John Creek	Cabin John Cr.	1.57
841-12-2003	Cabin John Creek	Cabin John Cr.	1.57
841-15-2003	Cabin John Creek	Cabin John Cr.	1.57
841-13-2003	Cabin John Creek	Cabin John Cr. UT	1.57
841-10-2003	Cabin John Creek	Old Farm Br.	1.29
841-1-2003	Cabin John Creek	Snakeden Br.	1.29

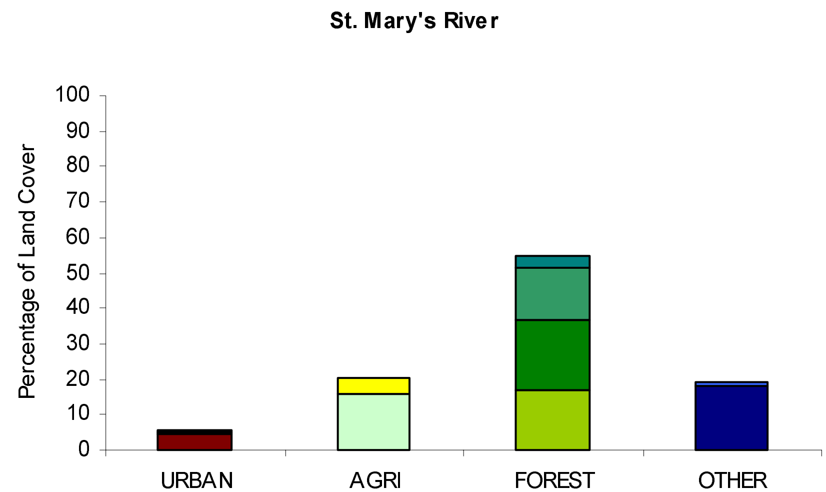


St. Mary's River watershed
MBSS 2003



St. Mary’s River





St. Mary's River

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
STMA-104-R-2003	MARTIN COVE UT1	021401030710	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	9-Jun-03	1	115
STMA-105-R-2003	ST MARY'S R	021401030719	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	26-Aug-03	1	630
STMA-106-R-2003	JARBOESVILLE RUN UT1	021401030717	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	13-Mar-03	9-Jun-03	1	726
STMA-107-R-2003	MARTIN COVE UT1	021401030710	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	9-Jun-03	1	136
STMA-112-R-2003	ST MARY'S R	021401030719	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	26-Aug-03	1	622
STMA-113-R-2003	CHURCH CR UT1	021401030711	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	10-Jun-03	1	488
STMA-115-R-2003	ST MARY'S R UT5	021401030710	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	9-Jun-03	1	37
STMA-119-R-2003	BROOM CR	021401030710	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	10-Jun-03	1	57
STMA-208-R-2003	JOHNS CR	021401030714	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	12-Mar-03	11-Jun-03	2	1635
STMA-218-R-2003	JARBOESVILLE RUN	021401030717	St. Mary's River	LOWER POTOMAC RIVER	St. Mary's	13-Mar-03	26-Aug-03	2	1463

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
STMA-104-R-2003	NR	2.71	85.35	0	0
STMA-105-R-2003	2.50	2.43	69.66	0	0
STMA-106-R-2003	3.25	1.57	76.28	0	0
STMA-107-R-2003	NR	3.00	81.49	0	0
STMA-112-R-2003	3.00	2.14	74.39	0	0
STMA-113-R-2003	2.25	2.43	84.3	0	0
STMA-115-R-2003	NR	1.29	72.16	0	0
STMA-119-R-2003	NR	3.00	89.07	0	0
STMA-208-R-2003	4.25	4.14	78.38	0	0
STMA-218-R-2003	4.50	2.14	86.82	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
STMA-104-R-2003	3.28	35.65	61.08	0.00	0.92
STMA-105-R-2003	23.16	13.87	44.96	18.01	12.40
STMA-106-R-2003	11.32	16.66	71.66	0.37	5.45
STMA-107-R-2003	5.85	34.63	59.51	0.00	1.54
STMA-112-R-2003	23.45	14.00	44.31	18.24	12.56
STMA-113-R-2003	1.96	6.44	91.60	0.00	0.58
STMA-115-R-2003	0.00	2.45	97.55	0.00	0.00
STMA-119-R-2003	0.00	29.96	67.32	2.72	0.00
STMA-208-R-2003	5.99	31.27	61.60	1.14	1.98
STMA-218-R-2003	20.67	18.89	60.08	0.37	8.07
Overall PSU					

Summary of Watershed Condition

- ANC low at most sites
- Turbidity high at some sites
- Nitrogen and phosphorus elevated at some sites
- Riffle/run quality 0 at three sites

St. Mary's River

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
STMA-104-R-2003	6.39	121.7	187.7	19.437	1.215	9.522	0.0318	0.004	0.0121	0.155	1.568	2.970	7.70	11.90
STMA-105-R-2003	6.27	154.7	122.9	29.514	0.000	8.471	0.0212	0.001	0.0004	0.010	0.274	6.924	2.90	8.60
STMA-106-R-2003	5.63	113.7	73.4	25.789	0.118	7.758	0.0124	0.001	0.0004	0.074	0.322	2.437	7.00	13.10
STMA-107-R-2003	6.90	135.6	417.7	18.412	1.018	12.961	0.0277	0.003	0.0097	0.299	1.517	3.555	7.70	11.90
STMA-112-R-2003	6.29	148.1	126.3	33.942	0.000	8.685	0.0213	0.001	0.0004	0.009	0.280	6.928	2.90	8.60
STMA-113-R-2003	5.59	57.5	19.2	8.968	0.096	8.742	0.0078	0.001	0.0004	0.005	0.193	3.349	8.50	5.90
STMA-115-R-2003	4.76	41.8	-13.1	4.854	0.000	6.644	0.0040	0.001	0.0004	0.006	0.098	3.867	7.50	7.50
STMA-119-R-2003	6.35	100.8	135.1	13.974	0.928	11.458	0.0160	0.001	0.0047	0.118	1.159	2.657	7.80	4.80
STMA-208-R-2003	6.18	106.5	62.9	15.988	1.246	12.901	0.0129	0.001	0.0015	0.014	1.431	4.222	7.70	3.30
STMA-218-R-2003	6.02	130.2	143.9	27.772	0.119	6.710	0.0168	0.001	0.0004	0.026	0.270	3.371	4.10	12.00

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
STMA-104-R-2003	50	50	FR	FR	13	9	6	14	46	12	31	40	95	12	45
STMA-105-R-2003	50	50	FR	FR	7	5	5	6	75	0	0	100	96	11	20
STMA-106-R-2003	0	0	PA	PA	13	14	11	11	57	14	18	35	85	16	51
STMA-107-R-2003	50	50	FR	FR	12	8	11	11	25	12	50	45	93	15	55
STMA-112-R-2003	50	50	FR	FR	10	9	5	9	75	0	0	80	97	13	34
STMA-113-R-2003	11	50	PA	FR	14	13	12	15	60	13	16	35	92	20	64
STMA-115-R-2003	50	50	FR	FR	10	6	11	11	46	12	18	80	98	18	52
STMA-119-R-2003	50	50	FR	FR	10	8	7	9	58	11	17	45	96	20	42
STMA-208-R-2003	50	50	FR	LN	16	13	13	16	60	15	21	40	93	10	78
STMA-218-R-2003	50	50	FR	FR	18	14	10	18	75	0	0	90	70	19	101

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
STMA-104-R-2003	N	N	N	N	Mild	Mild	Minor
STMA-105-R-2003	N	N	N	N	None	None	Minor
STMA-106-R-2003	Y	N	N	N	Moderate	Mild	Minor
STMA-107-R-2003	N	N	N	N	Severe	Mild	Moderate
STMA-112-R-2003	N	N	N	N	None	None	Minor
STMA-113-R-2003	N	N	N	N	Severe	Mild	Minor
STMA-115-R-2003	N	N	N	N	Severe	Severe	Moderate
STMA-119-R-2003	N	N	N	N	Moderate	Moderate	Moderate
STMA-208-R-2003	N	N	N	N	Mild	Mild	Minor
STMA-218-R-2003	N	N	N	N	None	None	None

St. Mary's River

Fish Species Present

AMERICAN EEL
BANDED KILLIFISH
BLACKNOSE DACE
BLUEGILL
BLUESPOTTED SUNFISH
BROWN BULLHEAD
CHAIN PICKEREL
CREEK CHUBSUCKER
EASTERN MUDMINNOW
FLIER
GOLDEN SHINER
LEAST BROOK LAMPREY
MARGINED MADTOM
PIRATE PERCH
PUMPKINSEED
REDBREAST SUNFISH
SWALLOWTAIL SHINER
TADPOLE MADTOM
TESSELLATED DARTER

Exotic Plants Present

MILE-A-MINUTE
JAPANESE HONEYSUCKLE
MICROSTEGIUM

Benthic Taxa Present

ABLABESMYIA
ACERPENNA
AESHNIDAE
ALLOCAPNIA
ANCHYTARSUS
ANCYLIDAE
ANCYRONYX
APSECTROTANYPUS
ASELLIDAE
BEROSUS
CAECIDOTEA
CERATOPOGON
CERATOPOGONIDAE
CHEUMATOPSYCHE
CHIMARRA
CHIRONOMIDAE
CHIRONOMINI
CHLOROPERLIDAE
CHRYSOPS
CLINOTANYPUS
CONCHAPELOPIA
CORYNONEURA
CRANGONYX
DIPLECTRONA
DIPLOCLADIUS
DIPTERA
DOLICHOPODIDAE
DUBIRAPHIA
DUGESIA
ECCOPTURA
ELMIDAE
ENCHYTRAEIDAE
EUKIEFFERIELLA
EURYLOPHELLA
GEORTHOCLADIUS
GOMPHIDAE
GYRINUS
HELENIELLA
HELISOMA
HELOBDELLA
HETEROPLECTRON
HETEROTRISSOCLADIUS
HEXATOMA
HYALELLA
HYDROBAENUS
HYDROPORUS
HYDROPSYCHE
IRONOQUIA
ISOTOMIDAE
LABRUNDINIA
LARSIA
LEPIDOSTOMA
LEPTOPHLEBIA
LEPTOPHLEBIIDAE
LEUCTRA
LEUCTRIDAE
LIMNEPHILIDAE
LIMNOPHYES
LUMBRICULIDAE
MENETUS
MICROPSECTRA
MICROTENDIPES
MOLANNODES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NATARSIA
NEOPHYLAX
NYCTIOPHYLAX
ORTHOCLADIINAE
OULIMNIUS
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PHAENOPSECTRA
PHYSELLA
POLYCENTROPUS
POLYPEDILUM
PROSIMULIUM
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PSEUDOSUCCINEA
SCIRTIDAE
SIALIS
SPHAERIIDAE
STEGOPTERNA
STENELMIS
STENOCHIRONOMUS
SYNURELLA
TABANUS
TANYPODINAE
TANYTARSINI
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIBELOS
TUBIFICIDAE
UNNIELLA
ZAVRELIMYIA

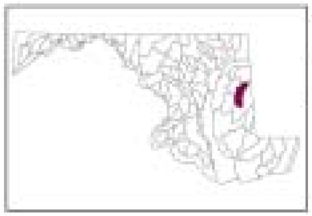
Herpetofauna Present

BULLFROG
EASTERN BOX TURTLE
GREEN FROG
NORTHERN COPPERHEAD
NORTHERN TWO-LINED SALAMANDER
SOUTHERN LEOPARD FROG

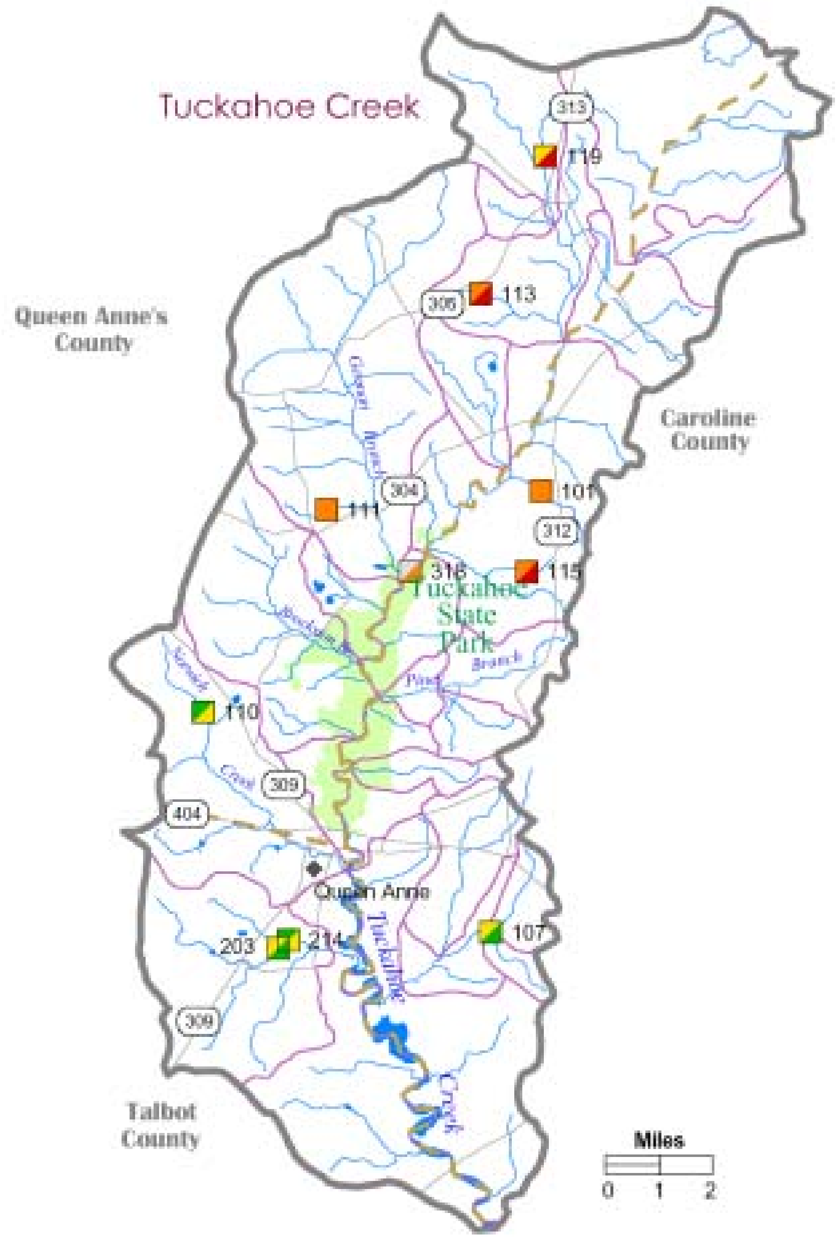
St. Mary's River

Stream Waders Data

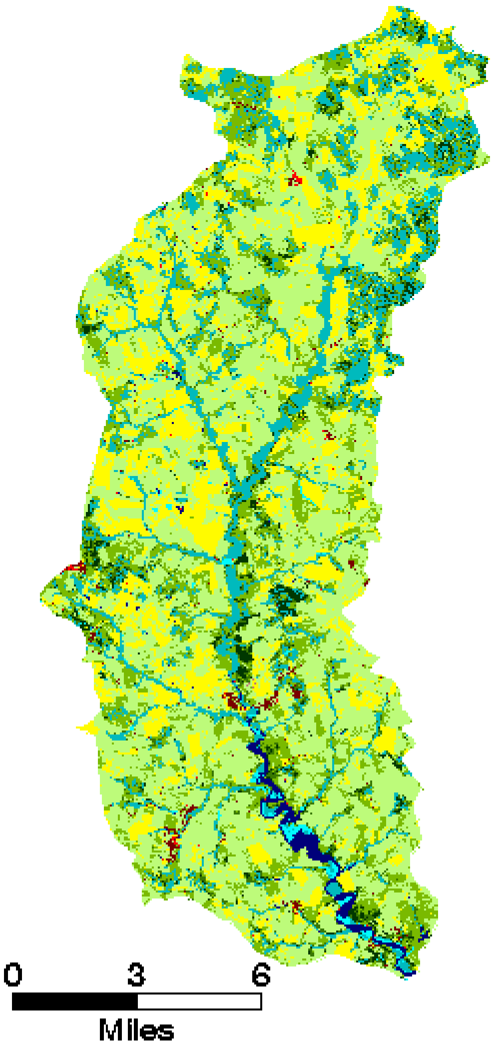
Site	8-digit Watershed	Stream Name	Benthic IBI
715-6-2003	St. Mary's River	Hilton Run	3.00
715-4-2003	St. Mary's River	Hilton Run	3.57
715-5-2003	St. Mary's River	Hilton Run	3.57
716-1-2003	St. Mary's River	Pembrook Run	3.86

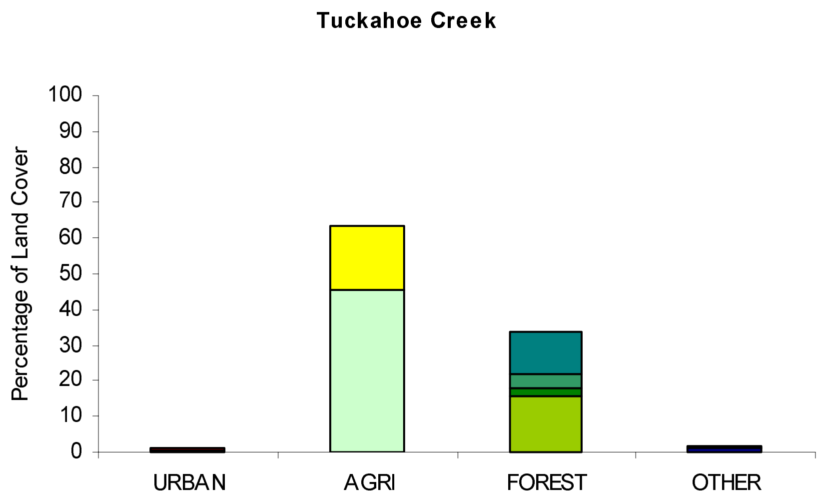


Tuckahoe Creek watershed
MBSS 2003



Tuckahoe Creek





Tuckahoe Creek

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
TUCK-101-R-2003	MASON BR UT3	021304050534	Tuckahoe Creek	CHOPTANK RIVER	Caroline	26-Mar-03	26-Jun-03	1	534
TUCK-107-R-2003	TUCKAHOE CR UT4	021304050521	Tuckahoe Creek	CHOPTANK RIVER	Caroline	25-Mar-03	14-Jul-03	1	1095
TUCK-110-R-2003	NORWICH CR	021304050522	Tuckahoe Creek	CHOPTANK RIVER	Queen Anne's	25-Mar-03	2-Jul-03	1	1594
TUCK-111-R-2003	GERMAN BR UT2	021304050538	Tuckahoe Creek	CHOPTANK RIVER	Queen Anne's	26-Mar-03	21-Jul-03	1	378
TUCK-113-R-2003	BEAVERDAM DITCH UT1	021304050536	Tuckahoe Creek	CHOPTANK RIVER	Queen Anne's	26-Mar-03	26-Jun-03	1	357
TUCK-115-R-2003	MASON BR UT4	021304050534	Tuckahoe Creek	CHOPTANK RIVER	Caroline	25-Mar-03	14-Jul-03	1	550
TUCK-119-R-2003	BEAVERDAM DITCH	021304050540	Tuckahoe Creek	CHOPTANK RIVER	Queen Anne's	3-Apr-03	26-Jun-03	1	753
TUCK-203-R-2003	TUCKAHOE CR UT2	021304050517	Tuckahoe Creek	CHOPTANK RIVER	Talbot	25-Mar-03	15-Jul-03	2	3604
TUCK-214-R-2003	TUCKAHOE CR UT2	021304050517	Tuckahoe Creek	CHOPTANK RIVER	Talbot	25-Mar-03	15-Jul-03	2	4605
TUCK-318-R-2003	MASON BR	021304050531	Tuckahoe Creek	CHOPTANK RIVER	Queen Anne's	26-Mar-03	NS	3	23127

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
TUCK-101-R-2003	2.50	2.14	86.11	0	0
TUCK-107-R-2003	3.25	4.14	81.83	0	0
TUCK-110-R-2003	4.25	3.57	69.1	0	0
TUCK-111-R-2003	2.50	2.14	86.1	0	0
TUCK-113-R-2003	2.25	1.57	60.4	0	0
TUCK-115-R-2003	2.00	1.29	79.31	0	0
TUCK-119-R-2003	3.00	1.57	46.99	0	1
TUCK-203-R-2003	3.50	4.14	73.82	0	0
TUCK-214-R-2003	4.00	3.86	66.9	0	0
TUCK-318-R-2003	NS	2.71	NS	NS	NS

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
TUCK-101-R-2003	0.42	66.61	32.76	0.21	0.13
TUCK-107-R-2003	0.55	79.53	19.90	0.02	0.14
TUCK-110-R-2003	4.88	48.56	44.68	1.89	1.96
TUCK-111-R-2003	0.35	83.28	16.19	0.18	0.12
TUCK-113-R-2003	0.31	69.71	29.91	0.06	0.08
TUCK-115-R-2003	0.16	83.49	16.35	0.00	0.04
TUCK-119-R-2003	0.41	61.02	38.24	0.33	0.16
TUCK-203-R-2003	4.09	66.44	29.13	0.33	1.28
TUCK-214-R-2003	3.32	68.50	27.83	0.35	1.04
TUCK-318-R-2003	0.62	62.47	36.66	0.25	0.24
Overall PSU					

Summary of Watershed Condition

- Nitrogen and phosphorus elevated throughout
- ANC low at three sites
- Turbidity high at two sites
- Three sites have 0 riffle/run quality; five sites have 100% embeddedness; channelization evident at most sites

Tuckahoe Creek

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
TUCK-101-R-2003	6.09	148.90	112.3	13.932	7.397	14.214	0.0314	0.001	0.0073	0.025	7.453	3.058	5.50	8.20
TUCK-107-R-2003	6.77	148.8	278.9	17.321	5.226	6.522	0.0205	0.006	0.0108	0.008	5.871	4.112	7.20	4.90
TUCK-110-R-2003	7.11	138.9	632.8	11.062	0.777	13.949	0.1114	0.028	0.0083	0.037	1.209	11.383	7.40	7.80
TUCK-111-R-2003	6.71	230.30	617.6	24.668	5.219	23.795	0.0480	0.016	0.0328	0.023	5.342	5.427	5.60	7.80
TUCK-113-R-2003	5.75	143.60	167.9	19.208	5.766	4.091	0.0355	0.005	0.0097	0.011	6.696	5.548	3.50	13.90
TUCK-115-R-2003	6.44	191.7	424.1	21.156	6.223	9.712	0.1146	0.091	0.0575	0.245	7.098	2.982	0.80	17.00
TUCK-119-R-2003	6.09	119.7	180.6	15.067	3.203	12.216	0.0447	0.012	0.0061	0.012	3.480	12.332	7.50	9.50
TUCK-203-R-2003	6.77	243.5	428.5	29.448	7.248	17.545	0.0332	0.016	0.0124	0.019	7.877	5.034	7.90	4.20
TUCK-214-R-2003	7.01	243.1	503.3	29.791	6.502	17.820	0.0373	0.015	0.0117	0.016	7.224	4.859	7.50	5.70
TUCK-318-R-2003	6.76	134.30	269.1	13.363	4.496	12.156	0.0385	0.007	0.0107	0.014	4.844	5.358	NS	NS

Physical Habitat Condition

Site	Riparian Buffer Width Left (m)	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
TUCK-101-R-2003	50	50	FR	FR	14	13	13	14	35	14	40	40	95	20	75
TUCK-107-R-2003	50	50	FR	FR	11	12	8	9	28	15	50	75	90	17	44
TUCK-110-R-2003	50	25	FR	CP	13	11	7	11	75	0	0	100	30	18	55
TUCK-111-R-2003	50	10	FR	CP	11	12	7	13	70	11	9	100	93	19	79
TUCK-113-R-2003	50	50	FR	FR	4	3	2	3	75	0	0	100	35	19	25
TUCK-115-R-2003	2	2	CP	CP	14	13	12	15	75	0	0	100	60	15	95
TUCK-119-R-2003	10	50	CP	TG	4	3	7	6	50	11	25	100	10	19	27
TUCK-203-R-2003	50	50	FR	FR	14	15	16	14	40	16	67	30	87	12	66
TUCK-214-R-2003	20	50	CP	FR	14	14	16	16	40	16	35	30	85	15	128
TUCK-318-R-2003	50	50	FR	FR	NS	NS	NS	NS	NS	NS	NS	NS	NS	19	NS

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
TUCK-101-R-2003	N	N	N	N	Moderate	Moderate	None
TUCK-107-R-2003	N	N	N	N	Mild	Mild	Minor
TUCK-110-R-2003	N	N	N	N	Mild	Mild	Minor
TUCK-111-R-2003	N	N	N	Y	Moderate	Moderate	Moderate
TUCK-113-R-2003	N	N	N	Y	None	None	Minor
TUCK-115-R-2003	N	N	N	Y	None	None	None
TUCK-119-R-2003	N	N	N	Y	None	Moderate	Minor
TUCK-203-R-2003	N	N	N	Y	Moderate	Moderate	Moderate
TUCK-214-R-2003	N	N	N	N	Severe	Severe	Minor
TUCK-318-R-2003	N	N	N	N	NS	NS	NS

Tuckahoe Creek

Fish Species Present

AMERICAN EEL
BLACK CRAPPIE
BLUEGILL
BROWN BULLHEAD
CHAIN PICKEREL
CREEK CHUBSUCKER
EASTERN MUDMINNOW
FALLFISH
GOLDEN SHINER
LARGEMOUTH BASS
LEAST BROOK LAMPREY
PIRATE PERCH
PUMPKINSEED
REDBREAST SUNFISH
REDFIN PICKEREL
SATINFIN SHINER
SPOTTAIL SHINER
TADPOLE MADTOM
TESSELLATED DARTER
WHITE SUCKER

Exotic Plants Present

MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM
PHRAGMITES
JAPANESE KNOTWEED

Benthic Taxa Present

ABLABESMYIA
ACERPENNA
AMPHIPODA
ANCYRONYX
ARGIA
CAECIDOTEA
CAENIS
CALLIBAETIS
CALOPTERYX
CAMBARIDAE
CHAETOCLADIUS
CHAETOGASTER
CHEUMATOPSYCHE
CHIRONOMIDAE
CHIRONOMUS
CHRYSOPS
CLINOTANYPUS
CLIOPERLA
CNEPHIA
COENAGRIONIDAE
CONCHAPELOPIA
CORBICULA
CORIXIDAE
CRANGONYX
CRICOTOPUS
CRYPTOCHIRONOMUS
CULICOIDES
CURA
DICROTENDIPES
DIPLOCLADIUS
DUBIRAPHIA
DYTISCIDAE
ENCHYTRAEIDAE
EPHEMERELLA
EURYLOPHELLA
GAMMARUS
HELICHUS
HEMERODROMIA
HYDROBAENUS
HYDROCHUS
HYDROPORUS
HYDROPSYCHIDAE
ISOPERLA
ISOTOMURUS
KIEFFERULUS
LABRUNDINIA
LEPTOCERIDAE
LEPTOPHLEBIIDAE
LIMNEPHILUS
LUMBRICULIDAE
LYPE
MACRONYCHUS
MENETUS
MICROTENDIPES
MUSCULIUM
NAIDIDAE
NANOCLADIUS
NECTOPSYCHE
NEMOURIDAE
NEOPHYLAX
NIGRONIA
NYCTIOPHYLAX
ORTHOCLADIINAE
ORTHOCLADIUS
OULIMNIUS
PARAMERINA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PARATANYTARSUS
PARATENDIPES
PHAENOPSECTRA
PHYSELLA
POLYPEDILUM
POTTHASTIA
PROSIMULIUM
PROSTOIA
PROSTOMA
PSEPHENUS
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
RHEOCRICOTOPUS
RHEOTANYTARSUS
SIMULIIDAE
SIMULIUM
SPHAERIIDAE
SPHAERIUM
STAGNICOLA
STEGOPTERNA
STEMPELLINELLA
STENACRON
STENELMIS
STENONEMA
STILOCLADIUS
STYGONECTES
SYNURELLA
TABANUS
TANYPODINAE
TANYTARSINI
TANYTARSUS
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIAENODES
TRIBELOS
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

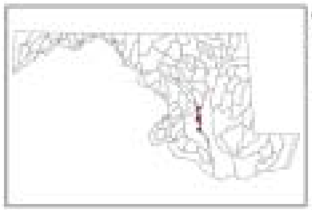
Herpetofauna Present

AMERICAN TOAD
BULLFROG
COMMON SNAPPING TURTLE
EASTERN GARTER SNAKE
EASTERN PAINTED TURTLE
FOWLER'S TOAD
GREEN FROG
NORTHERN TWO-LINED SALAMANDER
PICKEREL FROG
SOUTHERN LEOPARD FROG
WOOD FROG

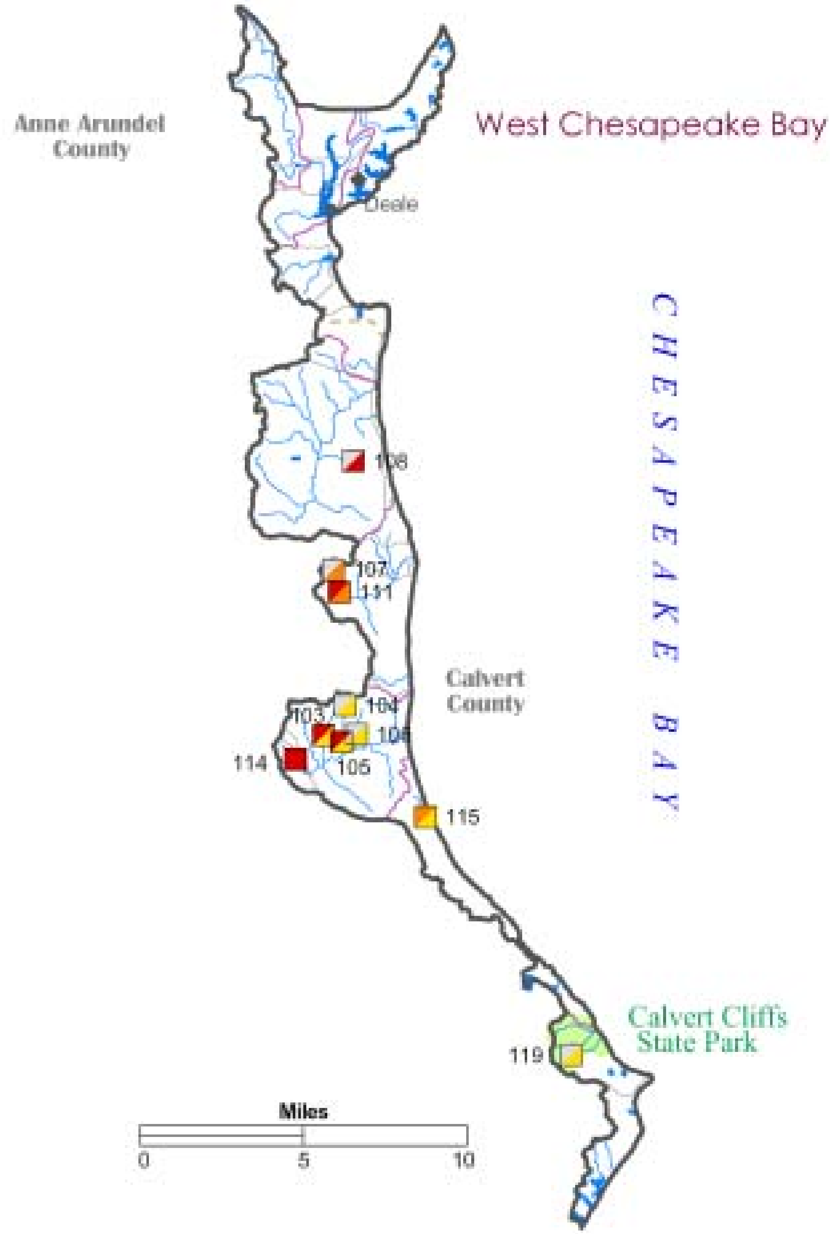
Tuckahoe Creek

Stream Waders Data

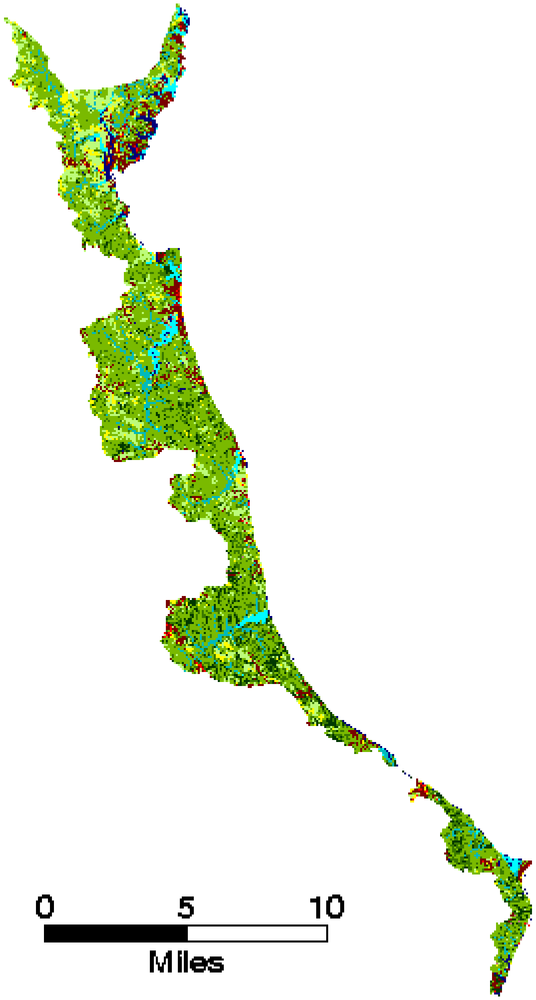
No Stream Waders data collected in 2003

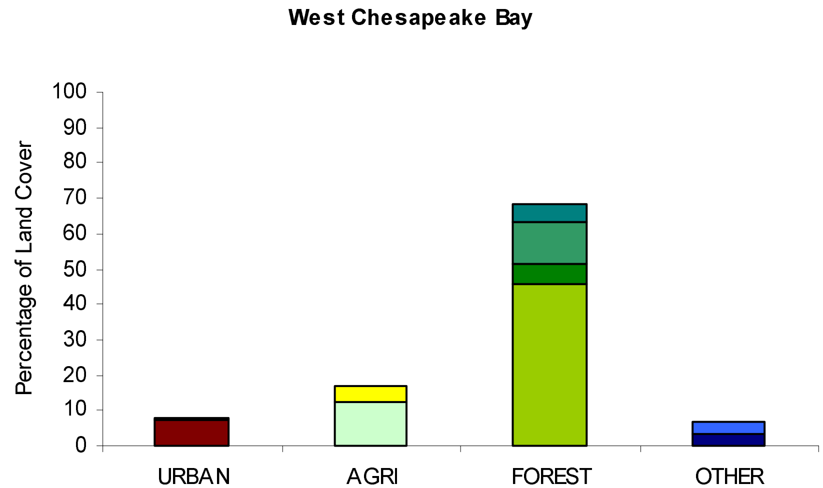


West Chesapeake Bay watershed
MBSS 2003



West Chesapeake Bay





West Chesapeake Bay

Site Information

Site	Stream Name	12-Digit Subwatershed Code	8-Digit Watershed	Basin	County	Date Sampled Spring	Date Sampled Summer	Order	Catchment Area (acres)
WCHE-103-R-2003	PARKER CR UT2	021310050976	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	5-Mar-03	5-Jun-03	1	479
WCHE-104-R-2003	PARKER CR UT1	021310050976	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	5-Mar-03	9-Jun-03	1	93
WCHE-105-R-2003	PARKER CR UT1	021310050976	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	6-Mar-03	5-Jun-03	1	434
WCHE-106-R-2003	PARKER CR UT3	021310050976	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	5-Mar-03	3-Jun-03	1	265
WCHE-107-R-2003	PLUM POINT CR	021310050977	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	5-Mar-03	3-Jun-03	1	57
WCHE-108-R-2003	FISHING CR UT2	021310050978	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	6-Mar-03	3-Jun-03	1	257
WCHE-111-R-2003	PLUM POINT CR	021310050977	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	6-Mar-03	9-Jun-03	1	465
WCHE-114-R-2003	SULLIVAN BR	021310050976	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	4-Mar-03	2-Jun-03	1	342
WCHE-115-R-2003	GOVERNOR RUN	021310050975	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	4-Mar-03	2-Jun-03	1	741
WCHE-119-R-2003	GRAYS CR	021310050974	West Chesapeake Bay	WEST CHESAPEAKE BAY	Calvert	6-Mar-03	2-Jun-03	1	187

Indicator Information

Site	FIBI	BIBI	PHI	Brook Trout Present	Blackwater Stream
WCHE-103-R-2003	1.50	3.29	64.12	0	0
WCHE-104-R-2003	NR	3.57	78.05	0	0
WCHE-105-R-2003	1.50	3.86	77.62	0	0
WCHE-106-R-2003	NR	3.00	80.88	0	0
WCHE-107-R-2003	NR	2.14	78.44	0	0
WCHE-108-R-2003	NR	1.57	71.19	0	0
WCHE-111-R-2003	1.50	2.14	73.74	0	0
WCHE-114-R-2003	1.50	1.57	60.98	0	0
WCHE-115-R-2003	2.00	3.29	68.48	0	0
WCHE-119-R-2003	NR	3.57	94.42	0	0

Catchment Land Use Information

Site	Percent Urban	Percent Agriculture	Percent Forest	Percent Other	Percent Impervious Surface
WCHE-103-R-2003	5.31	10.66	84.03	0.00	1.51
WCHE-104-R-2003	3.59	25.60	70.81	0.00	0.90
WCHE-105-R-2003	0.92	10.07	89.01	0.00	0.23
WCHE-106-R-2003	0.08	4.55	95.37	0.00	0.02
WCHE-107-R-2003	3.53	44.31	52.16	0.00	0.88
WCHE-108-R-2003	6.81	2.27	86.21	4.71	1.92
WCHE-111-R-2003	8.46	23.19	67.77	0.57	2.33
WCHE-114-R-2003	21.10	17.18	61.72	0.00	8.93
WCHE-115-R-2003	4.70	12.65	78.83	3.82	1.20
WCHE-119-R-2003	8.45	5.48	85.36	0.71	2.41
Overall PSU					

Summary of Watershed Condition

- Phosphorus and ammonia elevated throughout
- ANC low at three sites
- Turbidity high at six sites
- Some physical habitat parameters poor; 100% embeddedness at nine sites
- Evidence of severe erosion at several sites

West Chesapeake Bay

Water Chemistry Information

Site	Closed pH	Specific Cond.	ANC (μeq/L)	Cl (mg/L)	Nitrate-N (mg/L)	SO4 (mg/L)	T-P (mg/L)	Ortho-P (mg/L)	Nitrite-N (mg/L)	Ammonia (mg/L)	T-N (mg/L)	DOC (mg/L)	DO (mg/L)	Turbidity (NTUs
WCHE-103-R-2003	6.88	131.6	411.1	13.293	0.160	20.212	0.0827	0.004	0.0015	0.028	0.294	3.102	9.10	12.40
WCHE-104-R-2003	7.05	404.7	495.4	9.696	0.251	10.687	0.0644	0.006	0.0021	0.030	0.416	4.190	9.10	10.80
WCHE-105-R-2003	6.72	148.3	496.0	17.356	0.085	18.423	0.0986	0.008	0.0004	0.036	0.220	3.685	9.10	13.30
WCHE-106-R-2003	7.17	176.1	1011.4	5.205	0.005	27.351	0.0849	0.006	0.0004	0.053	0.151	2.728	9.30	9.10
WCHE-107-R-2003	6.37	207.4	128.0	45.034	0.494	17.690	0.0369	0.002	0.0004	0.010	0.658	3.909	8.40	11.80
WCHE-108-R-2003	6.75	207.6	461.0	33.859	0.083	19.746	0.0871	0.003	0.0026	0.026	0.320	4.238	8.40	13.40
WCHE-111-R-2003	5.99	136.2	90.0	21.552	0.433	20.959	0.0639	0.007	0.0004	0.014	0.551	2.847	9.30	8.80
WCHE-114-R-2003	7.02	386.0	684.3	22.921	0.192	15.346	0.0524	0.006	0.0039	0.109	0.472	4.566	9.70	10.30
WCHE-115-R-2003	7.61	235.6	1441.1	12.193	0.099	26.766	0.0573	0.021	0.0004	0.020	0.258	2.843	9.20	8.20
WCHE-119-R-2003	5.17	61.9	17.9	9.058	0.112	9.775	0.0087	0.001	0.0004	0.019	0.272	3.870	9.10	3.70

Physical Habitat Condition

Site	Riparian Buffer Width Lef (m)t	Riparian Buffer Width Right (m)	Adjacent Cover Left	Adjacent Cover Right	Instream Habitat Structure	Epifaunal Substrate	Velocity/ Depth Diversity	Pool/ Glide/ Eddy Quality	Extent of Pools (m)	Riffle/ Run Quality	Extent of Riffles (m)	% Embed-dedness	% Shading	Trash Rating	Maximum Depth (cm)
WCHE-103-R-2003	50	50	FR	FR	7	6	7	7	15	14	68	100	96	18	40
WCHE-104-R-2003	50	50	FR	OF	7	6	7	7	14	12	61	100	97	16	26
WCHE-105-R-2003	50	50	FR	FR	6	6	7	6	8	13	75	100	98	20	30
WCHE-106-R-2003	50	50	FR	FR	6	9	7	6	5	13	72	100	95	20	25
WCHE-107-R-2003	50	50	OF	FR	6	9	7	7	3	11	75	100	70	15	25
WCHE-108-R-2003	50	50	FR	FR	6	6	6	6	5	11	72	75	97	15	22
WCHE-111-R-2003	50	50	OF	FR	10	8	13	13	34	14	48	100	95	14	52
WCHE-114-R-2003	50	50	FR	FR	7	8	9	8	24	13	51	100	95	18	41
WCHE-115-R-2003	50	50	FR	FR	8	10	8	6	4	15	73	100	95	16	29
WCHE-119-R-2003	50	50	FR	FR	15	15	14	12	63	15	14	100	97	20	51

Physical Habitat Modifications

Site	Buffer Breaks?	Surface Mine?	Landfill?	Channelization?	Erosion Severity Left	Erosion Severity Right	Bar Formation
WCHE-103-R-2003	N	N	N	N	Severe	Severe	Minor
WCHE-104-R-2003	N	N	N	N	Severe	Severe	Moderate
WCHE-105-R-2003	N	N	N	N	Mild	Mild	Minor
WCHE-106-R-2003	N	N	N	N	Mild	Mild	Minor
WCHE-107-R-2003	N	N	N	N	None	None	None
WCHE-108-R-2003	N	N	N	N	Moderate	Moderate	Moderate
WCHE-111-R-2003	N	N	N	N	Moderate	Moderate	Minor
WCHE-114-R-2003	N	N	N	N	Severe	Severe	Moderate
WCHE-115-R-2003	N	N	N	N	Moderate	Moderate	Moderate
WCHE-119-R-2003	N	N	N	N	Mild	Mild	Minor

West Chesapeake Bay

Fish Species Present
AMERICAN EEL
BLACKNOSE DACE
BLUEGILL
EASTERN MUDMINNOW
LEAST BROOK LAMPREY

Exotic Plants Present
MULTIFLORA ROSE
JAPANESE HONEYSUCKLE
MICROSTEGIUM

Benthic Taxa Present
ALLOCAPNIA
AMPHINEMURA
ANCHYTARSUS
APSECTROTANYPUS
BOYERIA
CAECIDOTEA
CALOPTERYX
CAPNIIDAE
CERATOPOGON
CERATOPOGONIDAE
CHAETOCLADIUS
CHIMARRA
CHIRONOMINI
CHLOROPERLIDAE
CHRYSOPS
CLIOPERLA
COLLEMBOLA
CORDULEGASTER
CORYNONEURA
CRANGONYCTIDAE
CRICOTOPUS
CULICOIDES
CURA
DICRANOTA
DIPLOCLADIUS
DIPTERA
DOLICHOPODIDAE
DOLOPHILODES
ECCOPTURA
ENCHYTRAEIDAE
EPHEMERELLA
EPHEMEROPTERA
GAMMARUS
GOMPHIDAE
HELICHUS
HEPTAGENIIDAE
HEXATOMA
HYDROBAENUS
HYDROBIUS
IRONOQUIA
ISOPERLA
LEPIDOPTERA
LEPTOPHLEBIA
LEPTOPHLEBIIDAE
LEUCTRA
LIBELLULA
LIMNEPHILIDAE
LUMBRICULIDAE
LYPE
MICROPSECTRA
MUSCULIUM
NANOCLADIUS
NATARSIA
NEMOURIDAE
NIGRONIA
OECETIS
ORMOSIA
OSTROCERCA
PARACHAETOCLADIUS
PARALEPTOPHLEBIA
PARAMETRIOCNEMUS
PARAPHAENOCLADIUS
PERLIDAE
PHAENOPSECTRA
PHYSELLA
PLANORBIDAE
POLYPEDILUM
PROBEZZIA
PROSIMULIUM
PROSTOIA
PSEUDOLIMNOPHILA
PSEUDORTHOCLADIUS
PSILOTRETA
PTILOSTOMIS
PTYCHOPTERA
PYCNOPSYCHE
RHEOTANYTARSUS
RHYACOPHILA
SIPHLONURUS
SMITTIA
SPHAERIIDAE
SPIROSPERMA
STAGNICOLA
STEGOPTERNA
STENOCHIRONOMUS
STENONEMA
STYGONECTES
SYNURELLA
TAENIOPTERYX
TANYPODINAE
TANYTARSINI
THIENEMANNIELLA
THIENEMANNIMYIA GROUP
TIPULA
TIPULIDAE
TRIAENODES
TUBIFICIDAE
TVETENIA
ZAVRELIMYIA

Herpetofauna Present
BULLFROG
EASTERN BOX TURTLE
FOUR-TOED SALAMANDER
FOWLER'S TOAD
GREEN FROG
MARBLED SALAMANDER
NORTHERN TWO-LINED SALAMANDER
NORTHERN WATER SNAKE
PICKEREL FROG
RED SALAMANDER
SOUTHERN LEOPARD FROG

West Chesapeake Bay

Stream Waders Data

No Stream Waders data collected in 2003

5 TEMPORAL CHANGES IN PARAMETER ESTIMATES FOR 8-DIGIT WATERSHEDS

As each round of statewide sampling by the MBSS (or the Survey) is conducted at regular intervals over time, temporal changes (trends) in the stream condition statewide and for individual 8-digit watersheds can be evaluated. Such monitoring data are necessary to assess whether implementation of Total Maximum Daily Loadings (TMDLs) and other restoration measures are effective in achieving or maintaining water quality standards (or in effecting other improvements in stream quality). The MBSS also provides information on physical parameters that can be used to track changes in habitat conditions and link such changes to trends in water quality. While these comparisons may be useful, it is important to remember that some method occurred between rounds.

This chapter compares results for the fourth year of MBSS Round Two (2003) with data from Round One (1995-1997).

The detection of trends in mean IBI scores statewide, or for individual watersheds requires a time series of data. Although exact statistics can be obtained for ≥ 2 years, a minimum of four or more rounds of samples collected over time is required to obtain meaningful results using the non-parametric Mann-Kendall test for trends (Gilbert 1987, Hirsch et al. 1982). While it is true that evaluating some fixed sites that are stable in terms of land use and other stressors would ideally provide additional information on year-to-year variabilities across a wide range of conditions, resources were not available for this type of supplemental effort during the Round Two MBSS.

Statewide estimates of the percentage of stream miles falling into specific condition classes can be made using the three years (2000-2003) of Round Two data collected up to this point. These estimates will be further refined when Round Two of the MBSS is completed in 2004. Estimates from Round Two can be compared to estimates made using Round One data, to aid in the assessment of the change in stream condition over time.

Estimates of the percentage of stream miles falling into each condition class for both Round One and Round Two are presented in Figures 5-1 through 5-3. These figures indicate that statewide results from both Rounds of the MBSS are very similar. It can be concluded that the biological and physical condition of streams statewide have remained relatively constant over time since 1995, the beginning of Round One of the Survey.

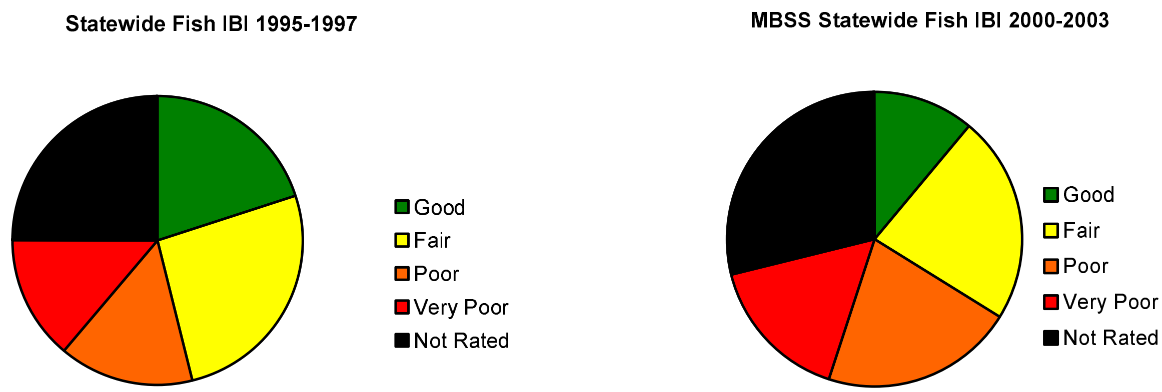


Figure 5-1. State estimates of the percentage of stream miles in Good, Fair, Poor and Very Poor condition classes for the Fish IBI in Round One and Round Two of the MBSS

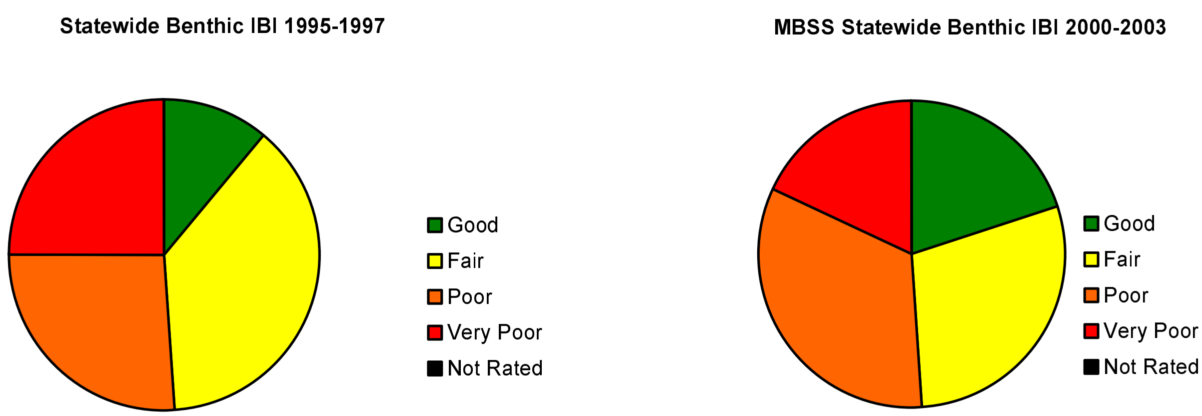


Figure 5-2. State estimates of the percentage of stream miles in Good, Fair, Poor and Very Poor condition classes for the Benthic IBI in Round One and Round Two of the MBSS

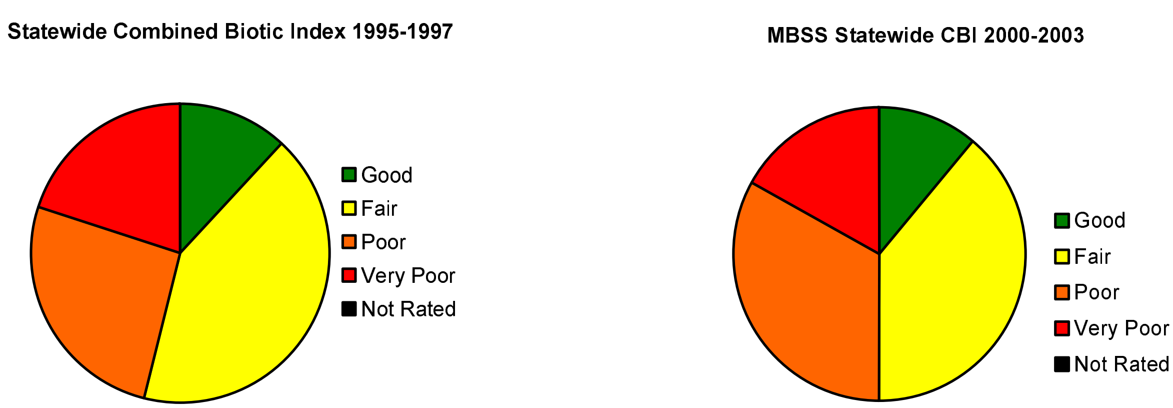


Figure 5-3. State estimates of the percentage of stream miles in Good, Fair, Poor and Very Poor condition classes for the Combined IBI in Round One and Round Two of the MBSS

6 SENTINEL SITES

Round Two of the Maryland Biological Stream Survey (MBSS or the Survey) provides an opportunity to examine trends in stream conditions over time. However, to accurately assess temporal trends, it is necessary to differentiate between changes that result from anthropogenic influences and those that result from natural variation. The MBSS is monitoring annually a network of high quality reference sites, known as Sentinel Sites, to aid in assessing natural year-to-year variability in stream conditions.

In natural streams, variability in ecological condition among years should be attributable only to variations in precipitation and temperature regimes, as well as to biotic interactions among native species. Therefore, annual monitoring information from minimally disturbed sites in locations not likely to experience future anthropogenic disturbance (i.e., Sentinel Sites) offers the best means of interpreting the degree to which changes in biological indicator scores result from natural variability. Understanding the variability of disturbed sites is also important for evaluating status and trends. However, assuring that stressor conditions do not change at disturbed sites over time is more problematic. The Survey is not currently sampling a network of fixed location disturbed sites.

Although there are no longer any pristine streams in Maryland, monitoring a set of the best remaining streams offers a reasonable alternative for evaluating natural variability. During 2000, the Survey established the Sentinel Site network. In 2001, 2002, and 2003, the Survey continued annual sampling at a set of Sentinel Sites. The following sections describe the methods used to select these sites and presents the sampling results from these sites in 2001, 2002, and 2003.

6.1 CANDIDATE SITES

To ensure that sites with minimal anthropogenic impacts were selected as long-term Sentinel Sites, a three-tiered framework of land use, water quality, and biological community criteria was established and applied to all sites sampled by the MBSS from 1995 to 1999. The following Tier 1 criteria were used to identify candidate Sentinel Sites:

- No evidence of acid mine drainage in the site catchment
- Sulfate < 50 mg/l
- pH > 6.0 or DOC > 8.0 mg/l (i.e., pH could be < 6 if the stream is a naturally acidic blackwater)
- Nitrate nitrogen < 4.0 mg/l
- Percent forested land use > 50% of catchment area
- Combined Biotic Index (CBI, calculated as the mean of FIBI and BIBI scores) > 3.0, or coldwater or blackwater stream

In addition, streams not previously sampled quantitatively by MBSS, but likely to meet the above criteria, were included in the initial pool of candidate sites.

Candidate Sentinel Sites were grouped according to stream order and geographic region (Coastal Plain-Eastern Shore, Coastal Plain-Western Shore, Eastern Piedmont, or Highlands) to facilitate representation of small, medium, and large streams throughout Maryland. Criteria were also applied to ensure that the candidate sites were likely to remain minimally disturbed for the foreseeable future. The Tier 2 list of provisional sites was compiled using the following criteria:

- minimum of 5 sites in each geographic region
- minimum of 5 sites in each stream order (1^{st} through 3^{rd})
- a large amount of the catchment located within protected lands (e.g., The Nature Conservancy Preserves and state forests), and
- sampling site itself located on public land.

Therefore, the provisional Sentinel Sites consisted of six or seven sites in each of the four geographic regions that appeared to have the least human disturbance and the least likelihood of changing in the future from human-related activities in their catchments. To compile the final Tier 3 selected Sentinel Sites, DNR biologists reviewed information from external sources and conducted site visits (when needed to confirm land use or other watershed conditions).

6.2 SITES SELECTED

Prior to the 2000 MBSS sampling season, 27 sites were selected for the Sentinel Site network using the three-tiered process based on the land use, water quality, and biological community criteria described above (Appendix Table D-1). These sites were either selected from sites sampled during Round One of the Survey, or from streams with existing ecological and land use information warranting their inclusion.

The 2000 Sentinel Site network was reviewed for potential changes in light of the 2000 sampling results and a slightly modified group was selected for 2001. Based on results from 2000, 24 of the 27 Sentinel Sites continued to meet the minimum Sentinel Site criteria. NASS-301-S-2000 was excluded from the Sentinel Site network because forested land use did not exceed 50% (42% forested land use). Two additional sites (WCHE-086-S-2000 and WYER-118-S-2000) were flagged for possible exclusion because the Combined Biotic Index (CBI) score in 2000 did not exceed 3.0 (and these sites were not coldwater or blackwater streams).

Of the 294 sites sampled by the Survey in 2000 (including the 27 Sentinel Sites), 91 met the criteria used to identify candidate Sentinel Sites (Appendix Table D-2). To ensure that adequate numbers of Sentinel Sites were available in each geographic region, new sites sampled in 2000 that met the candidate criteria were considered as potential replacements for excluded Sentinel Sites. Site STMA-104-R-2000 was proposed as a replacement for WCHE-086-S-2000 (Coastal Plain-Western Shore). Site STMA-104-R-2000 is located on Warehouse Run in Saint Mary's County, a stream that has excellent water quality conditions, high biological index scores, and a catchment dominated by forested land use. Located on Kirby Creek in Queen Anne's County, CORS-102-R-2000, a blackwater stream with good water quality and a catchment dominated by forested land use, was proposed as a replacement for WYER-118-S-2000 (Coastal Plain-Eastern Shore; Appendix Table D-2). Because NASS-301-S-2000 was located on a minimally disturbed, blackwater stream, a replacement site (NASS-302-S-2001) was selected downstream in the watershed so that the percent forested land use would meet the minimum criterion. In addition, although JONE-322-S-2000, LOCH-102-S-2000, and LOCH-209-S-2000 (Eastern Piedmont) met the minimum Sentinel Site criteria based on sampled results in 2000, additional information revealed anthropogenic impacts that warranted their exclusion from the Sentinel Site network. At the same time, FURN-101-C-2000 and LIBE-102-C-2000 were selected as new Sentinel Sites. Both sites are located on streams that have excellent water quality with catchments dominated by forested land use (Appendix Table D-2). Following these changes, 26 Sentinel Sites were designated for sampling in 2001 (Appendix Table D-3).

Of the 256 sites sampled by the Survey in 2001 (including the 26 Sentinel Sites), 76 met the criteria used to identify candidate Sentinel Sites (Appendix Table D-4). Of the 26 Sentinel Sites, 25 continued to meet the minimum Sentinel Site criteria after being sampled in 2001. Site WCHE-086-S-2001 did not meet criteria because the CBI score in 2001 was less than 3.0 (and the site is not located on a coldwater or blackwater stream). Because this site did not meet the Sentinel Site criteria for two consecutive years, PAXM-106-R-2001 was considered as a potential replacement. This alternate site is located on an unnamed tributary to Mataponi Creek in Prince George's County, and has good water quality and a CBI score that exceeds 4.00. To improve upon the existing Sentinel Site network in the Highlands region, SAVA-159-S-2001 was eliminated from the Sentinel Site list, and SAVA-204-C-2001 and UMON-119-S-2002 were added. Both sites are located on brook trout streams with excellent water quality and a catchment dominated by forested land use. Following these changes, 27 Sentinel Sites were designated for sampling in 2002 (Appendix Table D-5).

Of the 244 sites sampled by the Survey in 2002 (including the 27 Sentinel Sites), 61 met the criteria used to identify candidate Sentinel Sites (Appendix Table D-6). Of the 27 Sentinel Sites, 23 continued to meet the minimum Sentinel Site criteria after being sampled in 2002. The four Sentinel Sites that did not meet the criteria were all located in the Coastal Plain physiographic province. CORS-102-S-2002 and UPCK-113-S-2002 did not meet the Sentinel Site criteria because spring water chemistry data did not indicate blackwater conditions, despite the fact that previous data collected at these sites indicated that these appear to be blackwater streams. As a result, both of these sites will remain in the Sentinel Site network until further water quality data confirms that they should be excluded. In 2002, WIRH-220-S-2002 did not meet criteria because the nitrate-nitrogen concentration exceeded 4.0 mg/L. Water quality data collected over the past two years at this site suggests that land use changes within the watershed may be occurring. This site has been flagged for possible exclusion if water quality data from 2003 indicate elevated levels of nitrate-nitrogen. Lastly, MATT-033-S-2002 did not meet the Sentinel site criteria because the CBI score in 2002 did not exceed 3.0 (and this site is not located on a coldwater or blackwater stream). However, the Fish IBI component of the CBI was in the Poor category due to the extreme drought in 2002 which left this site with only a few standing pools. Therefore, variations in the CBI at this site are most likely due to natural variations. This site will remain in the Sentinel Site network. The only change made to the Sentinel Site network in 2002 was the elimination of WCHE-086-S-2002. Over the last five year, this site has been unable to consistently meet the criteria used to identify candidate Sentinel Sites. Following this change, 26 Sentinel Sites were designated for sampling in 2003 (Appendix Table D-7).

Of the 331 sites sampled by the Survey in 2003 (including the 26 Sentinel Sites), 68 met the Sentinel Site criteria (Appendix Table D-8). Of the 26 Sentinel Sites, 22 continued to meet the Sentinel Site criteria after being sampled in 2003. Of the four sites that did not meet the criteria, three of them were located in the Coastal Plain-Western Shore geographic region. All three of these sites

(PTOB-002-S-2003, STCL-051-S-2003, and ZEKI-012-S-2003) did not meet the criteria because the Combined Biotic Index (CBI) fell below 3.0 (and is not located on a coldwater or blackwater stream) (Appendix Table D-9). The low CBI scores observed at these sites are likely the result of the drought in 2002 (discussed in section 6.3). Since natural variations likely account for the low CBI scores, these sites will remain in the Sentinel Site network. In 2003, JONE-315-S-2003 did not meet the criteria because both the CBI fell below 3.0 (Appendix Table D-9). The low scores recorded at this site may not be the result of the drought of 2002, but from anthropogenic activities in the watershed (JONE-315-2003 has one of the lowest percentages of forested landuse in the Sentinel Site network). This site will remain in the Sentinel Site network for 2004 due to the difficulty in identifying larger streams in the Eastern Piedmont that meet the Sentinel Site criteria.

6.3 INTERANNUAL VARIABILITY AT SENTINEL SITES

The Combined Biotic Index, which rates the health of a stream based on both benthic macroinvertebrate and fish communities, can be used as a tool to document temporal trends that result from natural variations. Although only five years of data currently exist for most of the Sentinel Sites (Table 6.1), we examined the variability in the CBI over this period.

Prior to the 2003 sampling period, approximately 77% of the CBI scores for each Sentinel Site varied by less than 1.0 across years. Variability in the CBI was negligible for the Highland region (average range of CBI was 0.50 per site, maximum of 0.95), whereas the greatest variability in the CBI occurred for the Coastal Plain-Western Shore region (average of 0.98, maximum of 1.50). These analyses suggest that, overall, stream conditions remained fairly stable from 1995 through 2002. However, the drought of 2002 changed the CBI results dramatically in 2003. Only 54% of the CBI scores for each Sentinel Site varied by less than one, and 46% of the Sentinel Sites received their lowest CBI score in 2003 (Appendix Table D-9). The geographic region that was affected most by the drought was the Coastal Plain-Western Shore region (average variability of 1.58, with a maximum value of 1.96). Five of the six Sentinel Sites in this region received their lowest scores since monitoring at these sites was initiated.

Despite the fact that 2002 was a very dry year (refer to section 2.20 for details on climatic conditions during 2002), Sentinel Site CBI scores were not consistently low due to the drought and low flow conditions in 2002. The drought negatively affected a few sites in the Coastal Plain physiographic province. CORS-102-S-2002 and WCHE-086-S-2002 both went dry in the summer of 2002. In addition, MATT-033-S-2002 consisted only of a few standing pools and had the lowest FIBI score in the four years that it has been sampled. The real impact of the drought appeared to lag and was much more obvious in 2003, based on the CBI results. Overall, both benthic macroinvertebrate and fish community IBI scores were consistently low in the Coastal Plain-Western Shore region, thus documenting temporal trends that result from natural variability.

Values for most of the parameters assessed were not dramatically different between years at each Sentinel Site (Appendix Table D-9). The most notable changes included variations in the blackwater or brook trout designation for a site. For example, UPCK-113-S-2002 and CORS-102-S-2002 underwent changes in blackwater designations, based on the water chemistry definition of a blackwater system. In 2002, neither site met the dissolved organic carbon concentration and ANC requirements for blackwater designation, despite having met these criteria in previous years and in 2003 (Appendix Table D-9). JONE-109-S-2001 illustrates annual changes in brook trout designations, based on the presence of brook trout in the sample one year and their absence in the other year. In 2001, brook trout were not collected in the actual 75 meter long Sentinel Site, but sampling 20 meters downstream determined that brook trout were still present in this stream.

These changes in designation indicate that it is important to consider other available data in assigning coldwater or blackwater designations. For example, the use of temperature logger records will likely prove more reliable for identifying coldwater streams than relying on the capture of trout species (this method should identify historically coldwater streams from which trout have been extirpated for reasons other than temperature). In addition, field observations and site-specific knowledge regarding blackwater conditions can augment the strictly water-chemistry based definition, which uses single-point-in-time data that do not capture natural variations in DOC, pH, or ANC levels.

6.4 DISCUSSION

The existing Sentinel Site network contains some of the best freshwater streams left in Maryland (i.e., minimally disturbed and least likely to change in the future from human-related activities) and includes first- through third-order streams within each geographic region. However, noticeable differences exist in the quality of these best streams in each of the four geographic regions. The Highlands stratum contains eight streams with few apparent anthropogenic impacts. All eight have excellent water quality conditions, good biological index scores, and a catchment dominated by forested land use (76% or greater; Appendix Table D-9). Conversely, it was difficult to identify sites of comparable quality in the Coastal Plain-Western Shore, Eastern Piedmont, and especially the Coastal Plain-Eastern Shore. Although a number of sites in these regions met the minimum criteria for candidate Sentinel Sites, few were truly high quality. Frequently, anthropogenic impacts (mostly resulting from agricultural land use) were evident to some degree. Therefore, it is important to maintain adequate numbers of Sentinel Sites in all Maryland regions, while recognizing that the quality of sites varies among regions.

The Survey's Sentinel Site network is a valuable tool for interpreting stream conditions over time and informing water resources management. One potential use would be to adjust individual site fish and benthic IBI scores relative to the scores obtained at the Sentinel Sites. For example, in years where Sentinel Site scores were consistently low (as a result of natural variation such as drought and low flow conditions), random sites sampled that year would have their scores adjusted upward by the amount the Sentinel Site were lower than normal. Raw scores would be retained for most analyses, but adjusted scores could be used in water resources management to provide fair assessments across watersheds sampled in different years. The sites sampled in the Coastal Plain-Western Shore region in 2003 may be prime candidates for this adjustment. These adjustments will be undertaken at the end of the five-year Round Two sampling (after 2004), when a more accurate picture of natural variability is attained.

Ultimately, the utility of the Sentinel network will depend upon whether land use changes or other impacts arise in a significant number of Sentinel Site catchments, thereby reducing the ability of the network to define natural variability. Future sampling will determine whether high quality conditions continue at the locations included in the Sentinel Site network. Ideally, the presence of one or more Sentinel Sites in a state park or a county would influence land use decisions that would protect Sentinel Site catchments. As needed, Sentinel Sites may be replaced to ensure that adequate numbers of undisturbed sites are available in each geographic region. We hope that after several years, the Sentinel Site network will provide an accurate picture of the temporal variability in the best remaining streams in Maryland.

7 MANAGEMENT IMPLICATIONS AND FUTURE DIRECTIONS

The goal of the Maryland Biological Stream Survey (MBSS or Survey) is to provide natural resource managers, policymakers, and the public with the information they need to make effective natural resource decisions about the State's non-tidal streams and the watersheds they drain. For this reason, the Survey was designed to answer an initial set of 64 management questions. In the Round One report (Roth et al. 1999), many of these questions were answered, while some remained unanswered and new questions were raised. Many of the answers were the first scientifically defensible and management-relevant answers obtained for these questions.

By the end of Round One (1995-1997), it was apparent that certain management concerns had been refined and programmatic needs were evolving. The changes instituted in Round Two (2000-2004) were designed to address this changing management context without losing comparability with Round One data. This chapter focuses on the management implications of the results obtained in 2003, recognizing that this sampling year is only one of five and that many questions will only be answered after Round Two is completed. In addition to implications of the core survey results, this chapter discusses the future sampling and monitoring/assessment activities planned for Round Two and beyond.

7.1 MANAGEMENT IMPLICATIONS

Information from Round One of the Survey is being used to support management and policy initiatives at DNR. Results from sampling in Round Two will be used to help refine answers to the MBSS questions and to address new issues that arise. In addition to serving DNR's program needs, a number of other agencies and institutions have an interest in the Survey's answers to its primary objectives:

- assess the current status of biological resources in Maryland's non-tidal streams;
- quantify the extent to which acidic deposition has affected or may be affecting biological resources in the state;
- examine which other water chemistry, physical habitat, and land use factors are important in explaining the current status of biological resources in streams;
- provide a statewide inventory of stream biota; establish a benchmark for long-term monitoring of trends in these biological resources; and
- identify high quality and unique areas for protection; and
- target future local-scale assessments and mitigation measures needed to restore degraded biological resources.

<u>Chesapeake Bay Agreement</u>. The information being obtained by the Survey is useful for achieving the new stream corridor commitments of the Chesapeake Bay Program. The Chesapeake 2000 Agreement (signed by Virginia, Maryland, Pennsylvania, District of Columbia, U.S. EPA, and Chesapeake Bay Commission) newly recognizes "the need to focus on the individuality of each river, stream and creek" to meet the goal—"Preserve, protect and restore those habitats and natural areas that are vital to the survival and diversity of the living resources of the Bay and its rivers." Specifically, the Agreement commits to the following watershed-based actions:

- Develop and implement watershed management plans in two-thirds of the Bay watershed;
- Develop guidelines to ensure the aquatic health of stream corridors;
- Select pilot projects that promote stream corridor protection and restoration; and
- Make available information concerning the aquatic health of stream corridors.
- Develop stream corridor restoration goals based on local watershed management planning

Results from the Round Two sampling will be used to support these actions, just as Round One results were provided to the State's Tributary Strategies program to address the Bay Program's nutrient reduction goals.

<u>Maryland Land Conservation</u>. The stream corridor information provided by the Survey will also prove invaluable for statewide programs such as the riparian buffer restoration, Rural Legacy, and GreenPrint initiatives. As part of the Chesapeake Bay-wide goal of restoring 2,010 miles of riparian buffers in the Chesapeake Bay watershed by the year 2010, Maryland is restoring 1200 miles of riparian vegetation along its stream corridors. MBSS ground verification of remotely sensed riparian areas can be used, along with data on ecological stream condition, to determine where restoration will provide the greatest ecological and economic benefit. In a separate initiative, GreenPrint no longer exists. Stream corridors are an important part of the contiguous forest and wetland

habitats that make up the green infrastructure (linked hubs and corridors worthy of preservation or restoration). MBSS data on the condition of constituent streams will help assign priorities for the purchase of GreenPrint lands.

Clean Water Action Plan. The results of Round Two will continue to support Maryland's participation in the federal Clean Water Action Plan. Round One MBSS data were an essential component of the first Unified Watershed Assessment prepared under this Plan; specifically, DNR incorporated mean values by Maryland 8-digit watersheds for both the fish IBI and benthic IBI. These indicators provided some of the best information provided to U.S. EPA by any state. These IBIs were used with other indicators to help designate both Category 1 (priorities for restoration) and Category 3 (priorities for protection) watersheds within Maryland. Watershed Restoration Action Strategies are being developed for five of these priority watersheds, using MBSS and other data: Georges Creek (Allegany County), Little Patuxent River (Howard County), Middle Chester River (Kent County), Manokin River (Somerset County), and Coastal Bays (Worcester County). Because the design of Round Two focuses on the finer geographic scale of Maryland 8-digit watersheds, future Unified Watershed Assessments will be more complete and Watershed Restoration Action Strategies more easily implemented.

Water Quality Standards. In addition to supporting these targeting initiatives, the identification of degraded stream segments has implications for comprehensive protection under the Clean Water Act. Section 101 of the Act states that physical, chemical, and biological integrity of waters should be maintained. Stream segments that fail to do this can be designated as degraded and not attaining designated uses as part of their water quality standards. The Maryland Department of the Environment (MDE) implements the water quality standards program and prepares a 303(d) list of streams not meeting their designated uses.

U.S. EPA continues to encourage Maryland and other states to use biological criteria (biocriteria) to meet negotiated agreements for expanding their 303(d) lists. In response, MDE, DNR, and a multi-jurisdictional advisory group developed an interim biocriteria framework that incorporates stream ratings based on fish and benthic IBIs developed by the Survey (Roth et al. 2000, Stribling et al. 1998) to identify 8-digit watersheds and 12-digit subwatersheds that are impaired. Using combined Round One and 2000 MBSS data, these impairments have been included in the biennial 305(b) water quality report and the "Draft Methodologies for Listing Pollution Impaired Waterbodies on the 2002 303(d) List." Specifically, 178 biological impairments are included in the 2002 Integrated 303(d) List based on MBSS stream ratings of Poor or Very Poor. Ultimately, total maximum daily loads (TMDLs) must be developed for streams on this list for which an impairing substance (a pollutant) can be identified. Currently, MDE is exploring ways of using MBSS data to support development of a large number of nutrient, sediment, and other TMDLs over the next few years.

Another important use of MBSS biological data for the water quality standards program is refinement of aquatic life use designations. Each water body in Maryland has an associated designated use that (along with appropriate physical, chemical, and biological criteria, and antidegradation provisions) make up the water quality standard for that water body. While some streams have a special use, such as a reproducing trout stream, most have the same general aquatic life use (Antidegradation Tier 1). This general use designation does not capture the natural variability of Maryland streams and therefore does not extend any special protection to streams with unusually high biodiversity or ecological value. U.S. EPA is encouraging states to refine their aquatic life uses into categories with more precise biocriteria and greater antidegradation protections. Maryland is currently developing an Outstanding National Resource Water Antidegradation Tier 3, while evaluating approaches for an Antidegradation Tier 2 that is better than the minimum standard of "support of balanced indigenous populations and support of contact recreation," commonly referred to as "fishable-swimmable." Data from the Survey will be critical to establishing aquatic life use designations and biocriteria in streams for these tiers.

Maryland Biodiversity. The information on biological diversity collected by the Survey exceeds that needed to designate the ecological condition of individual watersheds. The extensive geographic reach and quantitative sampling results of the Survey provide an unusual opportunity for evaluating the distribution and abundance of species previously designated as rare only by anecdotal evidence. For example, the endemic checkered sculpin and several other species have been collected by the Survey in previously unreported locations. Based on the information gathered in Round One, Maryland DNR's Heritage and Biodiversity Programs reevaluated state designations of rare, threatened, and endangered species. Continued reevaluations, as well as MBSS data on unique combinations of species at the ecosystem and landscape levels, will provide critical new information to support biodiversity conservation in the state. MBSS data is also a key component of Maryland's Comprehensive Wildlife Management Plan. This important effort, designed to identify, protect, and ultimately restore biodiversity hotspots, will be greatly enhanced by data form the MBSS.

Support of Local Monitoring Programs. One of the most promising trends related to the Survey has been the increase in interest and activity among Maryland county governments, non-governmental organizations, private businesses, and volunteers in stream monitoring. The success of the Survey has encouraged these groups to base their water resource management more directly on monitoring results. Many have instituted their own monitoring programs, often drawing upon or adopting MBSS sampling protocols. Maryland DNR has facilitated this trend by providing training each year to interested individuals. In 2003, nearly 50 individuals from some 20 outside organizations participated in MBSS training.

Montgomery County is an example of a local government that has instituted an extensive stream monitoring program, and that is working closely with the Survey to integrate program activities, so that sampling is more cost-effective and assessment results are consistent and more precise. In addition, Maryland DNR has implemented a Stream Waders program that combines volunteer sampling effort with professional laboratory processing and quality assurance to greatly increase the number of streams that can be sampled. These efforts to support local stream monitoring will ultimately result in improved water resource management at all levels.

7.2 FUTURE DIRECTIONS

At the end of Round One, it was discovered that most of the original 64 MBSS questions that could not yet be answered dealt with identifying potential stressors using data not collected as part of the Survey. Much of this information will be gathered from other sources and linked to MBSS sites so that statewide estimates can be made of stressor extent (e.g., number of stream miles with point sources of contamination, amounts of pesticides applied by geographic area, or pattern of landscape patches in upstream catchments). The other issues of original and new interest dealt in large part with the need for finer geographic resolution. As described above, the Round Two design (including adoption of the new 1:100,000-scale stream network, focus on Maryland 8-digit watersheds, and volunteer monitoring at the 12-digit subwatershed scale) begins to provide this desired resolution. Issues that require continued scrutiny in future years include the following:

- Extending the Survey into tidal streams;
- Delineating more stream types requiring new indicators (e.g., coldwater and blackwater streams);
- Refining existing indicators (e.g., benthic macroinvertebrate and physical habitat) and developing new ones (e.g., streamside salamanders in small streams);
- Better characterization of existing and new stressors (e.g., estimating the contribution of eroded soil to sediment loading and the possible adverse effect of low flows resulting from water withdrawals);
- Improving identification of rare species habitats and other biodiversity components;
- Comparing among sample rounds for the detection of trends; and
- More coordination with counties for greater sample density or cost savings in areas of shared interest.

Better Stream Coverage. The Round Two design is capturing considerably more small streams and a few more larger streams than in Round One. This increased effort provides nearly comprehensive coverage of the stream resources in Maryland. The principal remaining gap is tidal streams, those not covered by tidewater monitoring at DNR. The Round Two design includes a component dedicated to tidal stream sampling that has not yet been implemented because of lack of funding. Specifically, the Round Two design includes pilot sampling of tidal streams that follows the lattice design used for non-tidal streams and includes the same subset of 84 watersheds for sampling each year. A random sample of 20 sites would be selected within each watershed containing tidal streams, and the number of sites allocated to each watershed would be proportional to their tidal stream length.

Development of New or Refined Stream Indicators. Analysis of Round One data revealed that Maryland contains substantial miles of streams that are ecologically distinct in terms of natural fish communities. Three kinds of streams were identified where the existing fish IBI is not an effective indicator of stream condition: (1) small streams draining catchments of less than 300 acres, (2) coldwater streams characterized by lower temperatures and prevalence of trout species, and (3) blackwater streams characterized by low pH and high organic content. In each case, separate reference conditions likely need to be used to develop appropriate indicators for these stream types. Recent analysis of MBSS data from limestone streams (characterized by high alkalinity and pH) indicated that separate reference conditions are not needed for these streams. Similar analysis of an independent U.S. EPA data set from the Mid-Atlantic Highlands came to the same conclusion.

Targeted sampling of MBSS streams for streamside salamanders was conducted in 2001 and 2002 in cooperation with the U.S. Geological Survey. Analysis of these data concluded that a stream salamander Index of Biotic Integrity (SS-IBI) incorporating four metrics (number of species, number of salamanders, percentage of adults, and percentage of intolerant salamanders) is an effective discriminator of stream condition in small streams. This would provide the Survey with a vertebrate indicator for streams draining less than 300 acres habitats with naturally low to zero fish diversity. Temperature loggers were deployed at nearly all randomly selected stream sites in 2003 (and will continue to be deployed throughout Round Two) to improve our ability to identify current coldwater streams. Historically coldwater, but currently degraded to warmwater conditions streams, may be identifiable using historic, geologic, and other geographic data. Round Two also includes ancillary sampling of coldwater and blackwater streams (which occur in too low proportions of total streams to be captured adequately by the core survey) that will be used to support development of appropriate fish IBIs for these streams. In both 2000 through 2001, 16 ancillary coldwater sites were sampled in both stressed and healthy coldwater streams; additional sampling of blackwater streams is planned for future years. Analysis of existing coldwater and blackwater stream data has begun in hopes of developing separate reference conditions, and ultimately separate indicators, for these stream types.

In Round One, a provisional indicator of physical habitat quality, the Physical Habitat Index (PHI), was developed from the quantitative and qualitative data collected in 1995-1997. The approach focused on including only those parameters that were significantly correlated with biological characteristics of interest. In 2001 and 2002, the Survey revisited its approach for assessing stream physical habitat quality by reanalyzing all existing physiccal habitat data and developing a new indicator independent of biological data. The MBSS has applied this new PHI into MBSS analyses in 2003.

Better Characterization of Stream Stressors. Effective characterization of stressors will continue to be an important part of the Survey. In many cases, accurate diagnosis of site-specific problems is beyond the capabilities of the Survey and follow-up monitoring is required. This will be the case in most watersheds highlighted for possible inclusion on the state's 303d list of impaired waters. Only when specific causes of degradation are identified and quantified can TMDLs be developed. Nonetheless, the Survey will continue to investigate new analyses of stressor data and produce estimates of the extent and severity of problems to help in natural resource management decision making.

In 2001, the Survey had two papers accepted that address the issue of stressor diagnosis in freshwater streams. One study analyzed MBSS data in drainage basins of mixed land uses and determined that urban land use is a strong indicator of the likelihood that IBIs will fail biocriteria thresholds. The model developed in this study can be used to screen out land use effects when searching for other stressors. In addition, the Survey developed an "expected species model" that diagnoses ecological stressors to stream fishes using species tolerances to 31 physical, chemical, and landscape variables. Like the other study, this approach found that impervious land cover was the most influential stressor on Maryland streams in terms of severity and extent.

Throughout Round Two, new information is being gathered on riparian buffer, exotic plants, channelization, bar formation, and bank erosion. The total area of eroding banks was reported as an indicator of the amount of sediment being contributed downstream by each watershed. Additional analysis is underway for MDE to identify individual or composite sediment indicators that can be used to identify watersheds degraded by sediment. In future years, statistics on these and other stressors will be developed.

Maryland Biodiversity. As Round Two continues to sample new streams throughout the state, we expect that new location records for many species will be reported. As these records accumulate, the Survey will make them available to the Maryland DNR Heritage and Biodiversity Programs for future listing reevaluations and management planning. The Survey will also conduct more analysis on unique combinations of species at the ecosystem and landscape levels. Specifically, biodiversity maps based on Round One MBSS data and rare, threatened, and endangered species data will be augmented with Round Two data and GAP analysis data developed by the Heritage and Biodiversity Programs and U.S. Fish and Wildlife Service.

At present, little work has been done to prepare species-specific management plans for unique or at-risk aquatic species. Because the Survey collects information that can be used to identify stressors within a watershed, MBSS data can serve as a logical starting point for developing restoration and protection strategies. Given that the Survey has produced abundance estimates for rare and unique fishes, prioritization of management plan development can be based on population size and known threats. In 2003, the Survey conducted targeted sampling for the Maryland DNR Heritage and Biodiversity Programs to refine the distributions of selected rare fishes. This information will be used when considering appropriate protection and restoration measures.

One of the most important benefits of collecting Round Two data will be the ability of the Survey to compare results over time and detect trends in natural variability, environmental degradation, and restoration success. The sampling in Round Two provides the first opportunity to compare stream condition in selected watersheds across the two rounds. Once Round Two is completed in 2004, rigorous statewide estimates with ample sample density will be used to investigate trends. The interpretation of trends requires that natural temporal change be characterized and understood. To this end, Round Two will continue to annually monitor 25 sentinel sites selected and sampled in 2000. These sites represent the best stream conditions in the state and focus on those areas least likely to change through anthropogenic impact (e.g., in state-managed or protected areas). As Round Two progresses, data from annual sampling of sentinel sites will be analyzed for natural temporal variability.

Integration with Local Monitoring Programs. Recognizing that the core and ancillary sampling by Maryland DNR will never be able to attain the sample density needed for all management decisions in the state, the Survey is focusing on coordination with other monitoring programs (usually county governments) during Round Two. In 2000, comparability analyses were conducted with the biological sampling program of Montgomery County with funding from U.S. EPA. Differences in sample frame, survey design, sampling methods, indicator construction, and reporting were investigated and procedures for combining the results of the two programs were developed. In 2001, a experimental methods comparison study for benthic sampling was conducted that evaluated the effectiveness and comparability of differences in sampling gear, size of subsamples, and level of taxonomy. Using these and other analyses, the Survey has developed guidance and data quality standards for sharing of information.

To the extent possible, sampling results (e.g., fish and benthic IBIs) are being integrated into combined estimates for public reporting throughout Round Two. The Survey will continue coordination with Montgomery, Prince George's, Howard, Baltimore, and other counties plus Baltimore City, in future years to ensure that programs obtain either greater sample densities or cost savings (from sharing sample sites) for monitoring Maryland streams. The Maryland Water Monitoring Council (MWMC) is playing an active role in encouraging these collaborations between state and local agencies.

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8 REFERENCES

Allan, J.D. and A.S. Flecker. 1993. Biodiversity conservation in running waters: Identifying the major factors that threaten destruction of riverine species and ecosystems. BioScience 43:32-42.

American Public Health Association (APHA). 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association, Washington, DC.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 841-B-99-002.

Barbour, M.T., and J.B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. In: Biological Criteria: Research and Regulation. U.S. Environmental Protection Agency, Washington, D.C. EPA-440/5-91-005. pp. 25-38.

Boward, D. 2001. Maryland Stream Waters Volunteer Stream Monitoring Manuals. Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division.

Boward, D. and E. Friedman. 2000. Maryland Biological Stream Survey Laboratory Methods for Benthic Macroinvertebrate Laboratory Processing and Taxonomy. Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, Annapolis, Maryland. CBWP-MANTA-EA-00-6

Boward, D.M., P.F. Kazyak, S.A. Stranko, M.K. Hurd, and T.P. Prochaska. 1999. *From the Mountains to the Sea: The State of Maryland's Freshwater Streams*. Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, Annapolis, Maryland with United States Environmental Protection Agency. EPA-903-R-00-023.

Cairns, J. and J.R. Pratt. 1993. A history of biological monitoring using benthic macroinvertebrates. In Rosenberg, D.M. and V.H. Resh, eds. *Freshwater Monitoring and Benthic Macroinvertebrates*. Chapman and Hall, New York.

Center for Watershed Protection. 1998. Raid Watershed Planning Handbook - A Resource Guide for Urban Subwatershed Management, Ellicott City, MD.

Clark, G.M., D. K. Mueller, and M. A. Mast. 2000. Nutrient concentrations and yields in undeveloped stream basins of the United States. Journal of the American Water Resources Association 36(4):849-860.

Cochran, W.G. 1977. Sampling Techniques. 3rd ed. New York: John Wiley and Sons.

Collett, D. 1999. *Modeling Binary Data*. Chapman & Hall/CRC. 369 pp.

COMAR (Code of Maryland Regulations). 1995. Code of Maryland Regulations: 26.08.02.03 - Water Quality Criteria Specific to Designated Uses. Maryland Department of the Environment. Baltimore, Maryland.

Currey, D.L., Southerland, M.T., J.H. Vølstad, G.M. Rogers, R.P. Morgan, and E. Nizeyimana Louis. 2004. A Method for Using Maryland Biological Stream Survey Data to Identify Sediment Impairments in Maryland Watersheds. Maryland Department of the Environment, Baltimore.

D'Elia, C. F., E.E Connor, N.L. Kaumeyer, C.W. Keefe, K.V. Wood, C.F. Zimmerman. 1997. Nutrient Analytical Services Laboratory Standard Operating Procedures, Technical Report Series No. 158-97. Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD.

Eaton, J. G., J. H. McCormick, B. E. Goodno, D. G. O'Brien, H. G. Stefany, M. Hondzo, R. M. Scheller. 1995. A field information-based system for estimating fish temperature tolerances. Fisheries 20(4):10-18.

Environmental Protection Agency (EPA). 1976. Quality criteria for water. U.S. Environmental Protection Agency, Washington, DC.

Environmental Protection Agency (EPA). 1987. Handbook of Methods for Acid Deposition Studies: Laboratory Analyses for Surface Water Chemistry. Office of Acid Deposition, Environmental Monitoring and Quality Assurance, U.S. Environmental Protection Agency, Washington, DC.

Environmental Protection Agency (EPA). 1993. R-EMAP: Regional Environmental Monitoring and Assessment Program. Office of Research and Development, Washington DC. EPA/625/R-93/012.

Environmental Protection Agency (EPA). 1999. Methods and Guidance for Analysis of Water. EPA 821-C-99-004. Office of Water, U.S. Environmental Protection Agency, Washington, DC.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York

Hall, L.W., Jr., R.P. Morgan, E.S. Perry, and A. Waltz. 1999. Development of a Physical Habitat Index for Maryland Freshwater Streams. Draft Report to Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, Annapolis, MD.

Hilsenhoff, W.L. 1987. An improved biotic index or organic stream pollution. Great Lakes Entomologist 20:31-39.

Hirsch, R.M., J.R. Slack, and R.A. Smith. 1982. Techniques of trend analysis for monthly water quality data. Water Resources Research 18(1): 107-121.

Horvitz, D. G. and D. J. Thompson. 1952. A generalization of sampling without replacement from a finite universe. Journal of the American Statistical Association 47: 663-685.

Jessen, R.J. 1978. Statistical Survey Techniques. John Wiley, New York.

Karr, J.R. 1993. Defining and assessing ecological integrity: beyond water quality. Environmental Toxicology and Chemistry 12:1521-1531.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication 5. 28 pp.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5:55-68.

Karr. J.R. 1991. Biological integrity: A long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Kazyak, P.F. 1994. Maryland Biological Stream Survey Sampling Manual. Prepared by Versar, Inc., Columbia, MD, for Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division.

Kazyak, P.F. 2001. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division.

Kerans, B.L. and J.R. Karr. 1994. A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee valley. Ecological Applications 4:768-785.

Kline, K.M. and R.P. Morgan. 2003. Summary of Quality Assurance/Quality Control Results from Spring 2003 Water Chemistry Analysis of the Maryland Biological Stream Survey. University of Maryland Center for Environmental Science Appalachian Laboratory.

Knapp, C.M., W.P. Saunders, D.G. Heimbuch, H.S. Greening, and G.J. Filbin. 1988. Maryland Synoptic Stream Chemistry Survey: Estimating the number and distribution of streams affected by or at risk from acidification. Prepared by International Science and Technology, Inc., Reston, VA, for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD. AD-88-2. NTIS No. PB88-213996/AS.

Korn, E.L. and B.I. Gearbard. 1999. Analysis of Health Surveys. John Wiley and Sons. New York. 382 pp.

Lenat, D.R. 1988. Water quality assessment of streams using a qualitative collection method for benthic macroinvertebrates. Journal of North American Benthological Society 7:222-223.

McCormick, J. H., K. E. F. Hokanson, B. R. Jones. 1972. Effects of temperature on growth and survival of young brook trout (S*alvelinus fontinalis*). J. Fish. Res. Board Can. 29:1107-1112.

Mid-Atlantic Coastal Stream Workgroup (MACS). 1996. Standard operating procedures and technical basis: Macroinvertebrate collection and habitat assessment for low-gradient nontidal streams. Delaware Department of Natural Resources and Environmental Conservation, Dover, Delaware.

Miller, D.L., P.M. Leonard, R.M. Hughes, J.R. Karr, P.B. Moyle, L.H. Schrader, B.A. Thompson, R.A. Daniels, K.S. Fausch, G.A. Fitzhugh, J.R. Gammon, D.B. Halliwell, P.L. Angermeier, and D.J. Orth. 1988. Regional applications of an index of biotic integrity for use in water resource management. Fisheries 13(5):12-20.

NOAA (National Oceanic and Atmospheric Administration). 1998. Climatological data annual summary, Maryland and Delaware, 1998. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 122, number 13.

NOAA (National Oceanic and Atmospheric Administration). 1999. Climatological data annual summary, Maryland and Delaware, 1999. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 123 , number 13.

NOAA (National Oceanic and Atmospheric Administration). 2000 Climatological data annual summary, Maryland and Delaware, 2000. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 124, number 13.

NOAA (National Oceanic and Atmospheric Administration). 2001. Climatological data annual summary, Maryland and Delaware, 2001. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 125, number 13.

NOAA (National Oceanic and Atmospheric Administration). 2002. Climatological data annual summary, Maryland and Delaware, 2002. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 126, number 13.

NOAA (National Oceanic and Atmospheric Administration). 2003. Climatological data annual summary, Maryland and Delaware, 2003. National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC. Volume 127, number 13.

Ohio Environmental Protection Agency. (Ohio EPA) 1987. Biological criteria for the protection of aquatic life. Volumes I-III. Ohio EPA, Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Paul, M.J., J.B. Stribling, R. Klauda, P. Kazyak, M. Southerland, and N. Roth. 2003. Further Development of a Physical Habitat Index for the Maryland Wadeable Freshwater Streams. Report to the Maryland Department of Natural Resources, Annapolis, MD.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA 440-4-89-001.

Ranasinghe, J.A., S.B. Weisberg, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1994. Chesapeake Bay Benthic Community Restoration Goals. Prepared by Versar, Inc. for U.S. EPA and the Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division.

Rankin, E.T. 1989. The Qualitative Habitat Evaluation Index (QHEI): Rationale, methods, and application. Ohio EPA, Division of Water Quality Planning and Assessment, Ecological Analysis Section, Columbus, OH.

Resh, V. H., 1995. Freshwater benthic macro-invertebrates and rapid assessment procedures for water quality monitoring in the developing and newly industrialized countries. In: Davis, W.S. and T.P. Simon, eds. 1995. Biological assessment and criteria: tools for water resource planning and decision making. Lewis Publishers, Boca Raton, FL.

Rogers, G., D. Baxter, J. Vølstad, and N. Roth. 2003 Maryland Biological Stream Survey Quality Assurance Report. 2004. Prepared by Versar, Inc., Columbia, MD for the Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division.

Roth, N.E., M.T. Southerland, G. Mercurio, J.C. Chaillou, P.F. Kazyak, S.S. Stranko, A.P. Prochaska, D.G. Heimbuch, and J.C. Seibel. 1999. State of the Streams: 1995-1997 Maryland Biological Stream Survey Results. Prepared by Versar, Inc., Columbia, MD, and Post, Buckley, Schuh, and Jernigan, Inc., Bowie MD, with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-99-6.

Roth, N.E., M.T. Southerland, J.C. Chaillou, P.F. Kazyak, and S.A. Stranko. 2000. Refinement and validation of a fish Index of Biotic Integrity for Maryland streams. Prepared by Versar, Inc., Columbia, MD, with Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division. CBWP-MANTA-EA-00-2.

Roth, N.E., J.H. Vølstad, G. Mercurio, and M.T. Southerland. 2001a. Biological Indicator Variability and Stream Monitoring Program Integration: A Maryland Case Study. Prepared by Versar, Inc., Columbia, MD, for U.S. Environmental Protection Agency, Office of Environmental Information and the Mid-Atlantic Integrated Assessment Program.

Roth, N.E., M.T. Southerland, G. Mercurio, and J.H. Vølstad. 2001b. Maryland Biological Stream Survey 2000-2004. Volume I: Ecological Assessment of Watersheds Sampled in 2000. Prepared by Versar, Inc., Columbia, MD with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. CBWP-MANTA-EA-01-5.

Roth, N.E., M.T. Southerland, G.M. Rogers, and J.H. Vølstad. 2003. Maryland Biological Stream Survey 2000-2004. Volume II: Ecological Assessment of Watersheds Sampled in 2001. Prepared by Versar, Inc., Columbia, MD with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division.

Roth, N.E., M.T. Southerland, G.M. Rogers, and J.H. Vølstad. 2004. Maryland Biological Stream Survey 2000-2004. Volume III: Ecological Assessment of Watersheds Sampled in 2002. Prepared by Versar, Inc., Columbia, MD with Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division.

Schenker, N. and J.F. Gentleman. 2001. On judging the significant of differences by examining the overlap between confidence intervals. The American Statistician. 55(3): 182-186.

Schindler, D.W. 1988. Effects of acid rain on freshwater ecosystems. Science 239:149-157.

Schueler, J. 1994. The Importance of Imperviousness. In Watershed Protection Techniques. 2(1): 233-239.

Shah, B.V., B.G. Barnwell, and G. S. Bieler. 1997. SUDAAN User's Manual, Release 7.5. Research Triangle Park, NC: Research Triangle Institute.

Simon, T.P. ed. 1999. *Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities.* CRC Press, Washington DC.

Southerland, M., N. Roth, G. Mercuiro, and J. Vølstad. 2000. Final Design and Procedures for MBSS 2001-2004 (Round Two). Memorandum to R. Klauda and P. Kazyak, Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division. February 10, 2000.

Southerland, M.T., J.H. Vølstad, G.M. Rogers, R.P. Morgan, E. Nizeyimana Louis, and D.L. Currey. 2004. A Method for Using Maryland Biological Stream Survey Data to Identify Sediment Impairments in Maryland Watersheds. A Report to Maryland Department of Environment by Versar, Inc., and University of Maryland.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions of the American Geophysical Union 38(6):913-920.

Stribling J.B., B.K. Jessup, J.S. White, D. Boward, and M. Hurd. 1998. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Prepared by Tetra Tech, Inc., Owings Mills, MD and Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Program. CBWP-MANTA-EA-98-3.

Thompson, S. K. 1992. *Sampling*. John Wiley & Sons. New York. 343 pp.

U.N. Statistical Office. 1950. The preparation of sample survey reports. Stat. Papers Series C, No. 1.

Vølstad, J. H.., N.K. Neerchal, N.E. Roth, and M.T. Southerland. 2002. Combining biotic indices of stream condition from multiple surveys in a Maryland Watershed, Biological Indicators.

Vølstad, J. H., M. Southerland, J. Chaillou, H. Wilson, D. Heimbuch, P. Jacobson and S. Weisberg. 1995. The Maryland Biological Stream Survey: The 1993 Pilot Study. Prepared by Versar, Inc., Columbia, MD, for Maryland Department of Natural Resources, Chesapeake Bay Research and Monitoring Division, Annapolis, MD. CBRM-AD-95-3.

Vølstad, J.H., M.T. Southerland, S.B. Weisberg, H.T. Wilson, D.G. Heimbuch, and J.C. Seibel. 1996. Maryland Biological Stream Survey: the 1994 Demonstration Project. Prepared by Versar, Inc., Columbia, MD, for Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, Annapolis, MD. CBWP-MANTA-EA-95-9.

Yetman, K. 2001. Stream Corridor Assessment Survey (SCA) Survey Protocols. Watershed Restoration Division, Chesapeake and Coastal Watershed Services, Maryland Department of Natural Resources, Annapolis, MD.

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APPENDIX A
PRECIPITATION DATA

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Table A-1. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 1998

Region	Jan-98	Deviation	Feb-98	Deviation	Mar-98	Deviation	Apr-98	Deviation	May-98	Deviation	Jun-98	Deviation	Jul-98	Deviation
Southern Eastern Shore	8.04	4.40	6.98	3.55	4.65	0.53	3.12	-0.05	4.46	1.00	5.15	1.76	1.52	-2.53
Central Eastern Shore	7.41	3.83	6.34	3.08	5.33	1.59	3.19	0.44	3.39	-0.56	5.10	1.45	1.40	-2.54
Lower Southern	6.69	3.41	7.00	3.96	6.35	2.66	3.51	0.32	4.29	0.21	6.95	3.23	1.02	-2.94
Upper Southern	5.77	2.72	5.94	3.00	6.37	2.96	3.75	0.43	4.74	0.52	4.01	0.31	1.69	-2.32
Northern Eastern Shore	5.65	2.38	4.30	0.98	6.03	2.48	3.65	0.37	4.92	0.91	4.92	0.93	3.42	-0.38
Northern Central	6.00	2.92	4.93	1.96	6.34	2.81	3.94	0.41	5.51	1.14	4.67	0.69	3.17	-0.63
Appalachian Mountain	4.50	1.89	5.29	2.74	3.32	0.01	4.76	1.32	3.91	-0.02	4.44	0.99	2.76	-0.78
Allegany Plateau	4.74	1.56	4.38	1.43	3.44	-0.52	5.54	1.47	5.01	0.64	6.54	2.46	3.29	-1.57
Average for State	6.10	2.89	5.65	2.59	5.23	1.57	3.93	0.59	4.53	0.48	5.22	1.48	2.28	-1.71

Table A-1. (Continued)

Region	Aug-98	Deviation	Sep-98	Deviation	Oct-98	Deviation	Nov-98	Deviation	Dec-98	Deviation	Annual	Deviation
Southern Eastern Shore	2.75	-2.12	1.53	-1.88	1.01	-2.17	1.10	-2.02	3.67	0.26	43.98	0.73
Central Eastern Shore	3.02	-1.38	1.34	-2.17	2.58	-0.49	1.02	-2.30	4.20	0.64	44.92	1.59
Lower Southern	1.55	-2.42	0.50	-3.17	1.28	-1.96	1.17	-2.22	2.50	-0.83	42.81	0.25
Upper Southern	1.31	-2.86	1.79	-1.79	0.92	-2.39	1.27	-2.16	1.79	-1.58	39.32	-3.16
Northern Eastern Shore	3.03	-0.85	2.86	-0.79	1.36	-1.78	0.90	-2.49	1.87	-1.82	42.63	-0.06
Northern Central	2.57	-1.28	1.82	-1.89	2.82	-0.52	1.10	-2.48	1.19	-2.28	44.06	0.85
Appalachian Mountain	2.29	-1.05	1.74	-1.46	1.33	-1.84	0.25	-2.86	0.85	-1.97	35.44	-3.03
Allegany Plateau	3.74	-0.09	3.26	-0.06	1.49	-1.68	0.48	-3.08	1.30	-2.38	43.21	-1.82
Average for State	2.53	-1.51	1.86	-1.65	1.60	-1.60	0.91	-2.45	2.17	-1.25	42.05	-0.58

Table A-2. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 1999 (NOAA 1999)

Region	Jan-99	Deviation	Feb-99	Deviation	Mar-99	Deviation	Apr-99	Deviation	May-99	Deviation	Jun-99	Deviation	Jul-99	Deiviation
Southern Eastern Shore	4.98	1.34	2.90	-0.53	4.65	0.53	3.12	-0.05	4.46	1.00	5.15	1.76	3.80	-0.25
Central Eastern Shore	5.68	2.10	2.58	-0.68	5.33	1.59	3.19	0.44	3.39	-0.56	5.10	1.45	4.93	0.99
Lower Southern	5.20	1.92	2.20	-0.84	6.35	2.66	3.51	0.32	4.29	0.21	6.95	3.23	2.21	-1.75
Upper Southern	5.43	2.38	2.34	-0.60	6.37	2.96	3.75	0.43	4.74	0.52	4.01	0.31	1.72	-2.29
Northern Eastern Shore	4.84	1.57	3.17	0.13	6.03	2.48	3.65	0.37	4.92	0.91	4.92	0.93	3.61	-0.19
Northern Central	6.02	2.94	3.04	0.07	6.34	2.81	3.94	0.41	5.51	1.14	4.67	0.69	1.60	-2.20
Appalachian Mountain	4.30	1.69	1.50	-1.05	3.32	0.01	4.76	1.32	3.91	-0.02	4.44	0.99	1.79	-1.75
Allegany Plateau	4.97	1.79	2.30	-0.65	3.44	-0.52	5.54	1.47	5.01	0.64	6.54	2.46	3.04	-1.82
Average for State	5.18	1.97	2.50	-0.52	5.23	1.57	3.93	0.59	4.53	0.48	5.22	1.48	2.84	-1.16

Table A-2. (Continued)

Region	Aug-99	Deviation	Sep-99	Deviation	Oct-99	Deviation	Nov-99	Deviation	Dec-99	Deviation	Annual	Deviation
Southern Eastern Shore	4.57	-0.30	9.19	5.78	4.70	1.52	1.70	-1.42	2.39	-1.02	45.80	2.55
Central Eastern Shore	4.55	0.15	12.86	9.35	3.36	0.29	1.93	-1.39	2.59	-0.97	48.11	4.78
Lower Southern	6.61	2.64	11.75	8.08	3.50	0.26	1.45	-1.94	2.25	-1.08	46.02	3.46
Upper Southern	5.68	1.51	12.21	8.63	2.66	-0.65	2.18	-1.22	3.08	-0.29	46.55	4.07
Northern Eastern Shore	4.43	0.55	16.13	12.48	3.19	0.05	2.30	-1.09	2.42	-1.27	50.84	8.15
Northern Central	4.51	0.663	10.78	7.07	2.88	-0.46	2.01	-1.57	3.10	-0.37	44.99	1.78
Appalachian Mountain	2.27	- 1.07	5.45	2.25	2.26	-0.91	1.72	-1.39	2.07	-0.75	34.34	-4.13
Allegany Plateau	2.08	-1.75	3.46	0.14	2.85	-0.32	3.31	-0.25	1.98	-1.70	37.61	-7.42
Average for State	4.34	0.30	10.23	6.72	3.18	-0.03	2.08	-1.28	2.49	-0.93	44.28	1.66

Table A-3. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 2000 (NOAA 2000)

Region	Jan-01	Deviation	Feb-01	Deviation	Mar-01	Deviation	Apr-01	Deviation	May-01	Deviation	Jun-01	Deviation	Jul-01	Deviation
Southern Eastern Shore	2.53	-1.11	2.66	-0.77	6.19	2.07	2.66	-5.10	3.72	0.26	3.93	0.54	4.84	0.79
Central Eastern Shore	3.51	-0.07	2.67	-0.59	5.57	1.83	1.54	-1.81	5.17	1.22	5.72	2.07	5.08	1.14
Lower Southern	NA	NA	2.30	-0.74	5.00	1.31	1.61	-1.58	6.73	2.65	5.27	1.55	7.73	3.77
Upper Southern	2.75	-0.30	2.22	-0.72	4.81	1.40	1.82	-1.50	5.01	0.79	5.17	1.47	5.25	1.24
Northern Eastern Shore	3.26	-0.01	3.26	0.22	5.78	2.23	1.97	-1.31	5.78	1.77	3.34	-0.65	6.22	2.42
Northern Central	3.98	0.90	1.94	-1.03	4.67	1.14	2.31	-1.22	3.76	-0.61	4.47	0.49	2.05	-1.75
Appalachian Mountain	1.94	-0.67	1.00	-1.55	4.00	0.69	2.30	-1.14	5.00	1.07	4.52	1.07	3.38	-0.16
Allegany Plateau	2.85	-0.33	1.76	-1.19	4.15	0.19	2.72	-1.35	4.70	0.33	6.30	2.22	6.83	1.97
Average for State	2.97	-0.23	2.23	-0.80	5.02	1.36	2.12	-1.88	4.98	0.94	4.84	1.10	5.17	1.18

Table A-3. (Continued)

Region	Aug-01	Deviation	Sep-01	Deviation	Oct-01	Deviation	Nov-01	Deviation	Dec-01	Deviation	Annual	Deviation
Southern Eastern Shore	6.11	1.24	1.74	-1.67	1.08	-2.10	0.06	-3.06	2.22	-1.19	37.74	-5.51
Central Eastern Shore	6.47	2.07	1.87	-1.64	1.01	-2.06	0.40	-2.92	1.97	-1.59	40.98	-2.35
Lower Southern	NA	NA	2.54	-1.13	0.88	-2.36	0.97	-2.42	1.98	-1.35	NA	NA
Upper Southern	4.87	0.70	2.48	-1.10	0.85	-2.46	1.28	-2.12	1.58	-1.79	38.09	-4.39
Northern Eastern Shore	NA	NA	3.18	-0.47	0.80	-2.34	1.36	-2.03	1.51	-2.18	NA	NA
Northern Central	3.11	-0.74	3.93	0.22	0.97	-2.37	1.70	-1.88	1.79	-1.68	34.68	-8.53
Appalachian Mountain	3.07	-0.27	2.06	-1.14	0.69	-2.48	1.40	-1.71	1.83	-0.99	31.19	-7.28
Allegany Plateau	2.84	-0.99	1.83	-1.49	131.00	-1.86	1.08	-2.48	3.12	-0.56	39.49	-5.54
Average for State	4.41	0.34	2.45	-1.05	17.16	-2.25	1.03	-2.33	2.00	-1.42	37.03	-5.60

Table A-4. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 2001 (NOAA 2001)

Region	Jan-01	Deviation	Feb-01	Deviation	Mar-01	Deviation	Apr-01	Deviation	May-01	Deviation	Jun-01	Deviation	Jul-01	Deviation
Southern Eastern Shore	2.53	-1.11	2.66	-0.77	6.19	2.07	2.66	-5.10	3.72	0.26	3.93	0.54	4.84	0.79
Central Eastern Shore	3.51	-0.07	2.67	-0.59	5.57	1.83	1.54	-1.81	5.17	1.22	5.72	2.07	5.08	1.14
Lower Southern	NA	NA	2.30	-0.74	5.00	1.31	1.61	-1.58	6.73	2.65	5.27	1.55	7.73	3.77
Upper Southern	2.75	-0.30	2.22	-0.72	4.81	1.40	1.82	-1.50	5.01	0.79	5.17	1.47	5.25	1.24
Northern Eastern Shore	3.26	-0.01	3.26	0.22	5.78	2.23	1.97	-1.31	5.78	1.77	3.34	-0.65	6.22	2.42
Northern Central	3.98	0.90	1.94	-1.03	4.67	1.14	2.31	-1.22	3.76	-0.61	4.47	0.49	2.05	-1.75
Appalachian Mountain	1.94	-0.67	1.00	-1.55	4.00	0.69	2.30	-1.14	5.00	1.07	4.52	1.07	3.38	-0.16
Allegany Plateau	2.85	-0.33	1.76	-1.19	4.15	0.19	2.72	-1.35	4.70	0.33	6.30	2.22	6.83	1.97
Average for State	2.97	-0.23	2.23	-0.80	5.02	1.36	2.12	-1.88	4.98	0.94	4.84	1.10	5.17	1.18

Table A-4. (Continued)

Region	Aug-01	Deviation	Sep-01	Deviation	Oct-01	Deviation	Nov-01	Deviation	Dec-01	Deviation	Annual	Deviation
Southern Eastern Shore	6.11	1.24	1.74	-1.67	1.08	-2.10	0.06	-3.06	2.22	-1.19	37.74	-5.51
Central Eastern Shore	6.47	2.07	1.87	-1.64	1.01	-2.06	0.40	-2.92	1.97	-1.59	40.98	-2.35
Lower Southern	NA	NA	2.54	-1.13	0.88	-2.36	0.97	-2.42	1.98	-1.35	NA	NA
Upper Southern	4.87	0.70	2.48	-1.10	0.85	-2.46	1.28	-2.12	1.58	-1.79	38.09	-4.39
Northern Eastern Shore	NA	NA	3.18	-0.47	0.80	-2.34	1.36	-2.03	1.51	-2.18	NA	NA
Northern Central	3.11	-0.74	3.93	0.22	0.97	-2.37	1.70	-1.88	1.79	-1.68	34.68	-8.53
Appalachian Mountain	3.07	-0.27	2.06	-1.14	0.69	-2.48	1.40	-1.71	1.83	-0.99	31.19	-7.28
Allegany Plateau	2.84	-0.99	1.83	-1.49	131.00	-1.86	1.08	-2.48	3.12	-0.56	39.49	-5.54
Average for State	4.41	0.34	2.45	-1.05	17.16	-2.25	1.03	-2.33	2.00	-1.42	37.03	-5.60

Table A-5. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 2002 (NOAA 2002)

Region	Jan-02	Deviation	Feb-02	Deviation	Mar-02	Deviation	Apr-02	Deviation	May-02	Deviation	Jun-02	Deviation	Jul-02	Deviation
Southern Eastern Shore	2.98	-0.66	1.02	-2.41	5.08	0.96	5.30	2.13	1.85	-1.61	2.84	-0.55	1.68	-2.37
Central Eastern Shore	2.74	-0.84	0.67	-2.59	4.55	0.81	3.98	0.63	2.10	-1.85	1.85	-1.80	1.47	-2.47
Lower Southern	2.29	-0.99	0.61	-2.43	4.74	1.05	2.95	-0.24	1.82	-2.26	3.39	-0.33	1.84	-2.12
Upper Southern	1.87	-1.18	0.34	-2.60	3.66	0.25	3.90	0.58	3.22	-1.00	2.24	-1.46	2.72	-1.29
Northern Eastern Shore	2.55	-0.72	0.63	-2.41	NA	NA	3.09	-0.19	4.37	0.36	1.88	-2.11	2.87	-0.93
Northern Central	2.07	-1.01	0.39	-2.28	4.03	0.50	2.77	-0.76	3.62	-0.75	2.94	-1.04	2.58	-1.22
Appalachian Mountain	1.83	-0.78	0.31	-2.24	4.04	0.70	4.17	0.73	4.34	0.41	3.22	-0.23	2.98	-0.56
Allegany Plateau	2.47	-0.71	0.81	-2.14	4.33	0.37	6.08	2.01	6.08	1.71	3.25	-0.83	5.77	0.91
Average for State	2.35	-0.86	0.60	-2.39	4.35	0.66	4.03	0.61	3.43	-0.62	2.70	-1.04	2.74	-1.26

Table A-5. (Continued)

Region	Aug-02	Deviation	Sep-02	Deviation	Oct-02	Deviation	Nov-02	Deviation	Dec-02	Deviation	Annual	Deviation
Southern Eastern Shore	3.36	-1.51	9.24	5.83	7.06	3.88	5.45	2.33	3.61	0.20	49.47	6.22
Central Eastern Shore	1.58	-2.82	4.66	1.15	6.55	3.48	4.82	1.50	3.62	0.06	38.59	-4.74
Lower Southern	2.63	-1.34	2.10	-1.57	7.11	3.87	4.55	1.16	4.64	1.31	38.67	-3.89
Upper Southern	3.31	-0.96	3.83	0.25	6.31	3.00	5.12	1.72	4.73	1.36	41.15	-1.33
Northern Eastern Shore	1.81	-2.07	4.22	0.57	6.93	3.79	5.34	1.95	5.34	1.65	NA	NA
Northern Central	3.38	-0.47	4.43	0.72	6.36	3.02	3.92	0.34	4.59	1.12	41.08	-2.13
Appalachian Mountain	3.21	-0.13	3.87	0.67	5.49	2.32	3.42	0.31	3.59	0.77	40.44	1.97
Allegany Plateau	2.39	-1.44	3.43	0.11	5.13	1.96	3.46	-0.10	3.18	-0.50	46.38	1.35
Average for State	2.71	-1.34	4.47	0.97	6.37	3.17	4.51	1.15	4.16	0.75	42.25	-0.36

Table A-6. Total monthly precipitation (inches) and deviation from normal for Maryland regions in 2003 (NOAA 2003)

Region	Jan-03	Deviation	Feb-03	Deviation	Mar-03	Deviation	Apr-03	Deviation	May-03	Deviation	Jun-03	Deviation	Jul-02	Deviation
Southern Eastern Shore	1.63	-2.01	5.74	2.31	5	0.88	4.09	0.92	4.97	1.51	4.73	1.34	5.45	1.4
Central Eastern Shore			8.11	4.85	4.03	0.29	3.05	-0.3	6.87	2.92	6.88	3.23	8.52	4.58
Lower Southern	2.07	-1.21	7.53	4.49	4.6	0.91	2.87	-0.32	7.16	3.08	6.43	2.71	6.12	2.16
Upper Southern	2.77	-0.28	6.68	3.74	4.25	0.84	2.76	-0.56	6.74	2.52	8.29	4.59	6.59	2.58
Northern Eastern Shore	2.16	-1.11	6.54	3.5	5.12	1.57	3.15	-0.13	6.34	2.33	8.2	4.21	6.29	2.49
Northern Central	2.89	-0.19	5.75	2.78	3.71	0.18	2.68	-0.85	7.11	2.74	6.78	2.8	4.03	0.23
Applachian Mountain	2.7	-0.33	2.91	-0.48	4.44	0.17	5.46	0.17	6.07	-0.15	6.87	-0.15	7.38	-0.07
Allegheny Plateau	2.92	-0.26	5.25	2.3	2.7	-1.26	3.26	-0.81	7.22	2.85	7.17	3.09	8.24	3.38
Average for State	2.448571	-0.77	6.06375	2.93625	4.23125	0.4475	3.415	-0.235	6.56	2.225	6.91875	2.7275	6.5775	2.09375

Table A-6. (Continued)

Region	Jul-03	Deviation	Aug-03	Deviation	Sep-03	Deviation	Oct-03	Deviation	Nov-03	Deviation	Dec-03	Deviation	Annual	Deviation
Southern Eastern Shore	5.45	1.4	5.56	0.69	6.96	3.55	4.14	0.96	5.11	1.99	7.2	3.79	60.58	17.33
Central Eastern Shore	8.52	4.58	6.57	2.17	6.85	3.34	4.12	1.05	5.87	2.55	4.83	1.27		
Lower Southern	6.12	2.16	5.28	1.31	8.3	4.63	3.68	0.44	5.52	2.13	4.54	1.21	64.1	21.54
Upper Southern	6.59	2.58	4.38	0.21	8.06	4.48	5.18	1.87	4.88	1.48	4.85	1.48	65.43	22.95
Northern Eastern Shore	6.29	2.49	4.71	0.83	8.12	4.47	3.88	0.74	4.43	1.04	4.48	0.79	63.42	20.73
Northern Central	4.03	0.23	5.49	1.64	9.12	5.41	5	1.66	4.53	0.95	5.06	1.59	62.15	18.94
Applachian Mountain	7.38	-0.07	7.56	0.27	6.51	-0.07	5.28	-0.11	4.77	0.41	3.97	1.15	63.92	0.81
Allegheny Plateau	8.24	3.38	6.22	2.39	8.58	5.26	2.84	-0.33	4.88	1.32	3.28	-0.4	62.56	17.53
Average for State	6.5775	2.09375	5.72125	1.18875	7.8125	3.88375	4.265	0.785	4.99875	1.48375	4.77625	1.36	63.16571	17.11857

APPENDIX B
PARAMETER ESTIMATES BY PSU
BASED ON 2003 MBSS SAMPLING

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Table B-1. Fish IBI					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	1.96	1.86	0.75	1.00	3.29
Georges Creek	1.21	1.00	0.32	1.00	1.86
Antietam Creek	2.37	2.29	0.66	1.29	3.29
Lower Monocacy	2.82	3.00	0.72	1.00	3.86
Catoctin Creek	2.40	2.14	1.03	1.00	3.86
Rock Creek/Cabin John Creek	2.78	3.00	0.75	1.67	3.67
Liberty Reservoir	2.61	2.45	0.66	1.67	3.89
St. Marys River	3.29	3.13	0.91	2.25	4.50
Magothy/Severn Rivers	2.63	2.63	0.52	2.00	3.25
Port Tobacco River	2.53	2.75	0.57	1.50	3.25
West Chesapeake Bay	1.60	1.50	0.22	1.50	2.00
Little Gunpowder Falls	3.03	3.22	0.82	1.67	4.33
Broad Creek	3.59	4.11	1.01	1.44	4.56
Lower Elk River PSU	3.88	3.96	0.58	3.00	4.50
Miles/Wye Rivers	3.22	3.50	0.78	1.50	4.00
Middle Chester River	3.30	3.38	0.42	2.50	4.00
Honga River PSU	3.38	3.38	1.24	2.50	4.25
Tuckahoe Creek	3.03	3.00	0.79	2.00	4.25
Pocomoke Sound PSU	3.17	3.50	0.58	2.50	3.50

Table B-2. Fish IBI < 3.0			
PSU	**Percentage of Stream Miles with FIBI < 3**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	90.91	58.72	32.19
Georges Creek	100	59.04	40.96
Antietam Creek	70	34.75	35.25
Lower Monocacy	46.15	19.22	26.93
Catoctin Creek	66.67	29.93	36.74
Rock Creek/Cabin John Creek	42.86	9.9	32.96
Liberty Reservoir	66.67	34.89	31.78
St. Marys River	33.33	4.33	29
Magothy/Severn Rivers	50	11.81	38.19
Port Tobacco River	77.78	39.99	37.79
West Chesapeake Bay	100	47.82	52.18
Little Gunpowder Falls	42.86	9.9	32.96
Broad Creek	12.5	0.32	12.18
Lower Elk River PSU	100	47.08	52.92
Miles/Wye Rivers	22.22	2.81	19.41
Middle Chester River	20	2.52	17.48
Honga River PSU	33.33	0.84	32.49
Tuckahoe Creek	44.44	13.7	30.74
Pocomoke Sound PSU	33.33	0.84	32.49

Table B-3. Benthic IBI					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	3.73	3.89	0.72	2.11	4.56
Georges Creek	3.22	3.33	1.05	1.44	4.78
Antietam Creek	2.90	2.78	0.64	1.89	3.89
Lower Monocacy	3.11	3.22	0.57	1.67	3.89
Catoctin Creek	3.54	3.78	0.71	2.11	4.56
Rock Creek/Cabin John Creek	2.33	2.33	0.38	1.67	3.00
Liberty Reservoir	3.33	3.44	0.69	1.89	4.56
St. Marys River	2.49	2.43	0.81	1.29	4.14
Magothy/Severn Rivers	2.83	2.43	1.24	1.57	4.71
Port Tobacco River	2.89	3.00	0.87	1.57	4.43
West Chesapeake Bay	2.80	3.14	0.86	1.57	3.86
Little Gunpowder Falls	2.91	3.00	0.71	1.44	3.67
Broad Creek	3.42	3.78	0.76	2.11	4.11
Lower Elk River PSU	3.20	3.73	1.13	1.57	4.33
Miles/Wye Rivers	2.69	2.71	0.91	1.57	4.14
Middle Chester River	2.60	2.71	0.39	1.86	3.00
Honga River PSU	1.91	1.57	1.02	1.00	4.43
Tuckahoe Creek	2.71	2.43	1.13	1.29	4.14
Pocomoke Sound PSU	1.71	1.57	0.61	1.00	3.00

Table B-4. Benthic IBI < 3.0			
PSU	**Percentage of Stream Miles with BIBI < 3**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	13.33	1.66	40.46
Georges Creek	40	12.16	73.76
Antietam Creek	57.14	28.86	82.34
Lower Monocacy	38.1	18.11	61.56
Catoctin Creek	21.43	4.66	50.8
Rock Creek/Cabin John Creek	90	55.5	99.75
Liberty Reservoir	33.33	11.82	61.62
St. Marys River	70	34.75	93.33
Magothy/Severn Rivers	70	34.75	93.33
Port Tobacco River	40	12.16	73.76
West Chesapeake Bay	40	12.16	73.76
Little Gunpowder Falls	50	18.71	81.29
Broad Creek	30	6.67	65.25
Lower Elk River PSU	44.44	13.7	78.8
Miles/Wye Rivers	60	26.24	87.84
Middle Chester River	70	34.75	93.33
Honga River PSU	72.73	39.03	93.98
Tuckahoe Creek	60	26.24	87.84
Pocomoke Sound PSU	90	55.5	99.75

Table B-5. Combined Biotic Index					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	3.00	2.99	0.58	2.11	4.11
Georges Creek	2.61	2.33	1.03	1.22	4.11
Antietam Creek	2.70	2.75	0.57	1.59	3.59
Lower Monocacy	2.99	3.11	0.55	1.67	3.89
Catoctin Creek	3.16	3.12	0.76	1.56	4.56
Rock Creek/Cabin John Creek	2.46	2.61	0.51	1.67	3.00
Liberty Reservoir	3.05	3.11	0.51	2.00	3.78
St. Marys River	2.73	2.64	0.75	1.29	4.20
Magothy/Severn Rivers	2.69	2.53	0.90	1.57	4.14
Port Tobacco River	2.73	2.74	0.43	2.25	3.71
West Chesapeake Bay	2.49	2.52	0.74	1.54	3.57
Little Gunpowder Falls	2.83	2.89	0.72	1.44	3.78
Broad Creek	3.39	3.50	0.79	2.00	4.34
Lower Elk River PSU	3.24	3.72	1.08	1.57	4.33
Miles/Wye Rivers	2.89	2.94	0.81	1.54	4.07
Middle Chester River	2.95	3.11	0.30	2.55	3.25
Honga River PSU	1.95	1.57	0.99	1.00	4.34
Tuckahoe Creek	2.86	2.52	0.89	1.64	3.93
Pocomoke Sound PSU	1.84	1.57	0.69	1.00	2.96

Table B-6. CBI < 3.0			
PSU	**Percentage of Stream Miles with CBI < 3**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	80	51.91	95.67
Georges Creek	70	34.75	93.33
Antietam Creek	92.86	66.13	99.82
Lower Monocacy	80.95	58.09	94.55
Catoctin Creek	71.43	41.9	91.61
Rock Creek/Cabin John Creek	100	69.15	100
Liberty Reservoir	80	51.91	95.67
St. Marys River	80	44.39	97.48
Magothy/Severn Rivers	90	55.55	99.75
Port Tobacco River	90	55.55	99.75
West Chesapeake Bay	70	34.75	93.33
Little Gunpowder Falls	100	69.15	100
Broad Creek	90	55.5	99.75
Lower Elk River PSU	88.89	51.75	99.72
Miles/Wye Rivers	100	69.15	100
Middle Chester River	100	69.15	100
Honga River PSU	90.91	58.72	99.77
Tuckahoe Creek	100	69.15	100
Pocomoke Sound PSU	100	69.15	100

Table B-7. Spring pH < 6			
PSU	**Percentage of Stream Miles with pH < 6**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	6.67	0.17	31.95
Georges Creek	10	0.25	44.5
Antietam Creek	7.14	0.18	33.87
Lower Monocacy	0	0	16.11
Catoctin Creek	0	0	23.16
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	0	0	21.8
St. Marys River	30	6.67	65.25
Magothy/Severn Rivers	20	2.52	55.61
Port Tobacco River	10	0.25	44.5
West Chesapeake Bay	20	2.52	55.61
Little Gunpowder Falls	0	0	30.85
Broad Creek	0	0	30.85
Lower Elk River PSU	0	0	33.63
Miles/Wye Rivers	0	0	30.85
Middle Chester River	0	0	30.85
Honga River PSU	36.36	10.93	69.21
Tuckahoe Creek	10	0.25	44.5
Pocomoke Sound PSU	0	0	30.85

Table B-8. Summer pH					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	200.34	223.20	108.18	10.98	367.10
Georges Creek	168.02	131.45	199.56	1.50	687.50
Antietam Creek	1921.45	1338.90	1755.17	37.50	5205.40
Lower Monocacy	697.58	396.40	655.00	85.10	2332.10
Catoctin Creek	632.70	686.15	241.20	68.70	939.50
Rock Creek/Cabin John Creek	912.61	768.40	555.52	305.90	1963.10
Liberty Reservoir	541.63	388.80	475.51	179.40	2120.20
St. Marys River	127.60	124.60	118.69	-13.10	417.70
Magothy/Severn Rivers	247.59	160.80	255.28	18.60	862.90
Port Tobacco River	432.46	74.65	502.72	18.80	1234.40
West Chesapeake Bay	601.37	495.70	456.49	17.90	1441.10
Little Gunpowder Falls	409.33	387.15	164.88	180.10	709.30
Broad Creek	294.67	279.14	201.12	72.60	818.40
Lower Elk River PSU	619.97	713.65	399.70	113.70	1510.90
Miles/Wye Rivers	533.88	532.04	121.66	271.00	763.30
Middle Chester River	427.79	412.70	184.33	203.20	818.70
Honga River PSU	132.92	165.10	114.26	-31.50	331.30
Tuckahoe Creek	361.51	351.50	187.19	112.30	632.80
Pocomoke Sound PSU	32.26	51.58	66.71	-97.70	127.40

Table B-9. ANC < 50 µeq/L			
PSU	**Percentage of Stream Miles with ANC < 50 µeq/L**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	6.67	0.17	31.95
Georges Creek	30	6.67	65.25
Antietam Creek	7.14	0.18	33.87
Lower Monocacy	0	0	16.11
Catoctin Creek	0	0	23.16
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	0	0	21.8
St. Marys River	20	2.52	55.61
Magothy/Severn Rivers	10	0.25	44.5
Port Tobacco River	20	2.52	55.61
West Chesapeake Bay	10	0.25	44.5
Little Gunpowder Falls	0	0	30.85
Broad Creek	0	0	30.85
Lower Elk River PSU	0	0	33.63
Miles/Wye Rivers	0	0	30.85
Middle Chester River	0	0	30.85
Honga River PSU	27.27	6.02	60.97
Tuckahoe Creek	0	0	30.85
Pocomoke Sound PSU	40	12.16	73.76

Table B-10. ANC < 200 µeq/L			
PSU	**Percentage of Stream Miles with ANC < 200 µeq/L**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	46.67	21.27	73.41
Georges Creek	80	44.39	97.48
Antietam Creek	7.14	0.18	33.87
Lower Monocacy	9.52	1.17	30.38
Catoctin Creek	7.14	0.18	33.87
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	6.67	0.17	31.95
St. Marys River	90	55.5	99.75
Magothy/Severn Rivers	60	26.24	87.84
Port Tobacco River	60	26.24	87.84
West Chesapeake Bay	30	6.67	65.25
Little Gunpowder Falls	10	0.25	44.5
Broad Creek	30	6.67	65.25
Lower Elk River PSU	22.22	2.81	60.01
Miles/Wye Rivers	0	0	30.85
Middle Chester River	0	0	30.85
Honga River PSU	72.73	39.03	93.98
Tuckahoe Creek	30	6.67	65.25
Pocomoke Sound PSU	100	69.15	100

Table B-11. Physical Habitat Indicator					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	83.01	84.30	16.18	46.24	100.00
Georges Creek	77.82	82.88	13.98	48.97	90.99
Antietam Creek	70.17	70.62	15.35	45.45	92.22
Lower Monocacy	75.52	77.18	9.62	50.70	89.50
Catoctin Creek	70.32	72.89	14.16	51.24	92.22
Rock Creek/Cabin John Creek	69.18	70.93	13.26	50.70	88.70
Liberty Reservoir	70.28	73.77	12.54	40.80	86.61
St. Marys River	79.79	79.94	6.62	69.66	89.07
Magothy/Severn Rivers	68.88	68.73	6.74	59.43	79.91
Port Tobacco River	73.75	74.77	9.74	50.22	84.69
West Chesapeake Bay	74.79	75.68	9.50	60.98	94.42
Little Gunpowder Falls	72.17	77.90	12.23	45.47	83.87
Broad Creek	73.49	74.80	6.38	65.89	84.66
Lower Elk River PSU	59.84	61.60	12.41	29.34	75.64
Miles/Wye Rivers	73.77	72.93	8.77	60.04	88.56
Middle Chester River	73.45	72.16	7.20	64.13	84.21
Honga River PSU	75.51	75.56	6.34	68.75	88.19
Tuckahoe Creek	72.28	73.82	12.97	46.99	86.11
Pocomoke Sound PSU	69.46	67.37	10.51	56.06	84.35

Table B-12. Percentage of Stream Miles with PHI < 65			
PSU	**Percentage of stream miles with PHI < 65**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	13.33	1.66	40.46
Georges Creek	10	0.25	44.5
Antietam Creek	41.67	15.17	72.33
Lower Monocacy	15	3.21	37.89
Catoctin Creek	33.33	9.92	65.11
Rock Creek/Cabin John Creek	40	12.16	73.76
Liberty Reservoir	26.67	7.79	55.1
St. Marys River	0	0	30.85
Magothy/Severn Rivers	22.22	2.81	60.01
Port Tobacco River	10	0.25	44.5
West Chesapeake Bay	20	2.52	55.61
Little Gunpowder Falls	22.22	2.81	60.01
Broad Creek	0	0	30.85
Lower Elk River PSU	60	26.24	87.84
Miles/Wye Rivers	10	0.25	44.5
Middle Chester River	10	0.25	44.5
Honga River PSU	0	0	30.85
Tuckahoe Creek	22.22	2.81	60.01
Pocomoke Sound PSU	40	12.16	73.76

Table B-13. Channelized

PSU	Percentage of Stream Miles Channelized	Lower 90% CI	Upper 90% CI
Potomac River L N Br	26.67	7.79	55.1
Georges Creek	20	2.52	55.61
Antietam Creek	14.29	1.78	42.81
Lower Monocacy	9.52	1.17	30.38
Catoctin Creek	21.43	4.66	50.8
Rock Creek/Cabin John Creek	40	12.16	73.76
Liberty Reservoir	13.33	1.66	40.46
St. Marys River	0	0	30.85
Magothy/Severn Rivers	10	0.25	44.5
Port Tobacco River	0	0	30.85
West Chesapeake Bay	0	0	30.85
Little Gunpowder Falls	10	0.25	44.5
Broad Creek	10	0.25	44.5
Lower Elk River PSU	11.11	0.28	48.25
Miles/Wye Rivers	20	2.52	55.61
Middle Chester River	0	0	30.85
Honga River PSU	63.64	30.79	89.07
Tuckahoe Creek	50	18.71	81.29
Pocomoke Sound PSU	100	69.15	100

Table B-14. Moderate to Severe Bank Erosion

PSU	Percentage of Stream Miles with Moderate to Severe Bank Erosion	Lower 90% CI	Upper 90% CI
Potomac River L N Br	13.33	1.66	40.46
Georges Creek	0	0	30.85
Antietam Creek	25	5.49	57.19
Lower Monocacy	70	45.72	88.11
Catoctin Creek	33.33	9.92	65.11
Rock Creek/Cabin John Creek	90	55.5	99.75
Liberty Reservoir	60	32.29	83.66
St. Marys River	50	18.71	81.29
Magothy/Severn Rivers	40	12.16	73.76
Port Tobacco River	70	34.75	93.33
West Chesapeake Bay	60	26.24	87.84
Little Gunpowder Falls	77.78	39.99	97.19
Broad Creek	50	18.71	81.29
Lower Elk River PSU	88.89	51.75	99.72
Miles/Wye Rivers	50	18.71	81.29
Middle Chester River	30	6.67	65.25
Honga River PSU	9.09	0.23	41.28
Tuckahoe Creek	55.56	21.2	86.3
Pocomoke Sound PSU	30	6.67	65.25

Table B-15. Moderate to Severe Bar Formation			
PSU	**Percentage of Stream Miles with Moderate to Severe Bar Formation**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	46.67	21.27	73.41
Georges Creek	20	2.52	55.61
Antietam Creek	25	5.49	57.19
Lower Monocacy	60	36.05	80.88
Catoctin Creek	33.33	9.92	65.11
Rock Creek/Cabin John Creek	70	34.75	93.33
Liberty Reservoir	46.67	21.27	73.41
St. Marys River	30	6.67	65.25
Magothy/Severn Rivers	30	6.67	65.25
Port Tobacco River	80	44.39	97.48
West Chesapeake Bay	40	12.16	73.76
Little Gunpowder Falls	33.33	7.49	70.07
Broad Creek	10	0.25	44.5
Lower Elk River PSU	66.67	29.93	92.51
Miles/Wye Rivers	70	34.75	93.33
Middle Chester River	0	0	30.85
Honga River PSU	36.36	10.93	69.21
Tuckahoe Creek	22.22	2.81	60.01
Pocomoke Sound PSU	60	26.24	87.84

Table B-16. No Riparian Buffer on at Least One Bank			
PSU	**Percentage of Stream Miles with No Riparian Buffer on at Least One Bank**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	6.67	0.17	31.95
Georges Creek	0	0	30.85
Antietam Creek	28.57	8.39	58.1
Lower Monocacy	9.52	1.17	30.38
Catoctin Creek	28.57	8.39	58.1
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	0	0	21.8
St. Marys River	10	0.25	44.5
Magothy/Severn Rivers	0	0	30.85
Port Tobacco River	0	0	30.85
West Chesapeake Bay	0	0	30.85
Little Gunpowder Falls	10	0.25	44.5
Broad Creek	10	0.25	44.5
Lower Elk River PSU	11.11	0.28	48.25
Miles/Wye Rivers	0	0	30.85
Middle Chester River	10	0.25	44.5
Honga River PSU	18.18	2.28	51.78
Tuckahoe Creek	0	0	30.85
Pocomoke Sound PSU	10	0.25	44.5

Table B-17. No Riparian Buffer on Both Banks			
PSU	**Percentage of Stream Miles with No Riparian Buffer Both Banks**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	6.67	0.17	31.95
Georges Creek	0	0	30.85
Antietam Creek	21.43	4.66	50.8
Lower Monocacy	4.76	0.12	23.82
Catoctin Creek	14.29	1.78	42.81
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	0	0	21.8
St. Marys River	10	0.25	44.5
Magothy/Severn Rivers	0	0	30.85
Port Tobacco River	0	0	30.85
West Chesapeake Bay	0	0	30.85
Little Gunpowder Falls	10	0.25	44.5
Broad Creek	10	0.25	44.5
Lower Elk River PSU	11.11	0.28	48.25
Miles/Wye Rivers	0	0	30.85
Middle Chester River	10	0.25	44.5
Honga River PSU	9.09	0.23	41.28
Tuckahoe Creek	0	0	30.85
Pocomoke Sound PSU	0	0	30.85

Table B-18. Extensive exotic plants			
PSU	**Percentage of Stream Miles with Exotic Plants Present**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	6.67	0.17	31.95
Georges Creek	0	0	30.85
Antietam Creek	16.67	2.09	48.41
Lower Monocacy	35	15.39	59.22
Catoctin Creek	25	5.49	57.19
Rock Creek/Cabin John Creek	60	26.24	87.84
Liberty Reservoir	26.67	7.79	55.1
St. Marys River	0	0	30.85
Magothy/Severn Rivers	10	0.25	44.5
Port Tobacco River	10	0.25	44.5
West Chesapeake Bay	10	0.25	44.5
Little Gunpowder Falls	44.44	13.7	78.8
Broad Creek	30	6.67	65.25
Lower Elk River PSU	11.11	0.28	48.25
Miles/Wye Rivers	0	0	30.85
Middle Chester River	20	2.52	55.61
Honga River PSU	0	0	28.49
Tuckahoe Creek	0	0	33.63
Pocomoke Sound PSU	0	0	30.85

Table B-19. Total Number of Rootwads and Woody Debris					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	2.53	2.00	2.10	0.00	7.00
Georges Creek	3.50	1.50	3.66	0.00	9.00
Antietam Creek	1.93	1.00	2.13	0.00	6.00
Lower Monocacy	3.67	2.00	3.72	0.00	13.00
Catoctin Creek	1.36	0.50	2.62	0.00	10.00
Rock Creek/Cabin John Creek	6.30	5.50	4.42	0.00	15.00
Liberty Reservoir	2.53	2.00	3.23	0.00	10.00
St. Marys River	8.90	7.50	6.44	2.00	21.00
Magothy/Severn Rivers	5.70	5.50	4.57	0.00	13.00
Port Tobacco River	7.70	7.00	6.27	1.00	21.00
West Chesapeake Bay	4.80	5.50	3.58	0.00	9.00
Little Gunpowder Falls	4.40	4.50	3.03	0.00	10.00
Broad Creek	3.00	2.00	3.06	0.00	9.00
Lower Elk River PSU	3.90	2.50	4.20	0.00	14.00
Miles/Wye Rivers	7.30	7.50	6.52	0.00	18.00
Middle Chester River	6.10	4.50	5.28	0.00	15.00
Honga River PSU	2.70	2.00	2.54	0.00	6.00
Tuckahoe Creek	5.22	5.00	4.79	0.00	13.00
Pocomoke Sound PSU	1.40	1.00	2.17	0.00	7.00

Table B-20. Total Number of Instream Woody Debris					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	1.80	2.00	1.37	0.00	5.00
Georges Creek	2.40	1.00	3.06	0.00	8.00
Antietam Creek	1.50	1.00	1.68	0.00	5.00
Lower Monocacy	2.20	1.00	2.48	0.00	10.00
Catoctin Creek	0.67	0.00	1.23	0.00	4.00
Rock Creek/Cabin John Creek	3.40	2.00	3.86	0.00	13.00
Liberty Reservoir	1.33	0.00	2.41	0.00	7.00
St. Marys River	6.00	5.50	5.79	1.00	21.00
Magothy/Severn Rivers	3.00	2.00	2.94	0.00	7.00
Port Tobacco River	5.70	3.50	6.13	0.00	19.00
West Chesapeake Bay	2.70	2.00	2.41	0.00	6.00
Little Gunpowder Falls	3.44	3.00	2.40	0.00	8.00
Broad Creek	1.20	0.50	1.69	0.00	5.00
Lower Elk River PSU	2.60	1.00	3.84	0.00	11.00
Miles/Wye Rivers	4.70	3.00	4.69	0.00	13.00
Middle Chester River	4.80	3.00	5.14	0.00	15.00
Honga River PSU	1.70	1.00	1.77	0.00	5.00
Tuckahoe Creek	3.33	4.00	2.96	0.00	9.00
Pocomoke Sound PSU	1.00	0.00	2.16	0.00	7.00

Table B-21. Total Number of Dewatered Woody Debris					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	6.20	4.00	4.54	0.00	13.00
Georges Creek	5.80	4.50	4.21	0.00	11.00
Antietam Creek	4.00	2.50	4.02	0.00	10.00
Lower Monocacy	4.15	4.00	3.65	0.00	16.00
Catoctin Creek	3.25	2.00	2.93	0.00	9.00
Rock Creek/Cabin John Creek	6.40	7.00	3.27	0.00	10.00
Liberty Reservoir	6.07	3.00	8.08	0.00	27.00
St. Marys River	3.30	2.50	3.53	0.00	12.00
Magothy/Severn Rivers	3.90	3.50	2.51	0.00	8.00
Port Tobacco River	10.80	4.00	12.93	1.00	41.00
West Chesapeake Bay	4.50	4.50	3.50	0.00	12.00
Little Gunpowder Falls	2.78	3.00	1.79	1.00	6.00
Broad Creek	2.60	1.00	3.63	0.00	11.00
Lower Elk River PSU	2.50	0.50	4.43	0.00	13.00
Miles/Wye Rivers	3.80	4.00	2.66	0.00	9.00
Middle Chester River	4.40	3.50	4.27	0.00	15.00
Honga River PSU	2.60	2.00	2.46	0.00	7.00
Tuckahoe Creek	5.11	5.00	5.60	0.00	17.00
Pocomoke Sound PSU	2.50	1.00	3.44	0.00	11.00

Table B-22. Total Number of Woody Debris					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	8.00	6.00	5.28	0.00	18.00
Georges Creek	8.20	6.00	6.56	0.00	17.00
Antietam Creek	4.71	3.50	4.53	0.00	13.00
Lower Monocacy	6.05	5.00	4.80	0.00	17.00
Catoctin Creek	3.36	2.00	3.73	0.00	11.00
Rock Creek/Cabin John Creek	9.80	9.00	6.29	0.00	23.00
Liberty Reservoir	7.40	3.00	8.91	0.00	27.00
St. Marys River	9.30	8.50	6.80	2.00	22.00
Magothy/Severn Rivers	6.90	8.50	4.04	0.00	12.00
Port Tobacco River	16.50	9.50	18.60	2.00	60.00
West Chesapeake Bay	7.20	6.50	4.80	0.00	14.00
Little Gunpowder Falls	5.60	4.50	3.69	0.00	11.00
Broad Creek	3.80	3.50	3.82	0.00	11.00
Lower Elk River PSU	5.10	2.00	7.99	0.00	21.00
Miles/Wye Rivers	8.50	7.50	6.28	0.00	17.00
Middle Chester River	9.20	7.00	8.20	0.00	26.00
Honga River PSU	4.30	6.00	3.23	0.00	8.00
Tuckahoe Creek	8.44	9.00	8.02	0.00	26.00
Pocomoke Sound PSU	3.50	2.00	4.48	0.00	12.00

Table B-23. Total Number of Instream Rootwads					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.73	0.00	1.03	0.00	3.00
Georges Creek	1.10	1.00	1.20	0.00	3.00
Antietam Creek	0.75	0.50	0.87	0.00	2.00
Lower Monocacy	1.65	1.00	2.01	0.00	8.00
Catoctin Creek	0.92	0.00	1.73	0.00	6.00
Rock Creek/Cabin John Creek	2.90	3.00	1.97	0.00	6.00
Liberty Reservoir	1.20	1.00	1.08	0.00	3.00
St. Marys River	2.90	2.50	3.51	0.00	10.00
Magothy/Severn Rivers	2.70	1.00	2.75	0.00	7.00
Port Tobacco River	2.00	1.00	2.00	0.00	6.00
West Chesapeake Bay	2.10	1.50	2.08	0.00	7.00
Little Gunpowder Falls	1.44	1.00	0.88	0.00	3.00
Broad Creek	1.80	1.50	1.62	0.00	5.00
Lower Elk River PSU	1.30	1.00	1.16	0.00	3.00
Miles/Wye Rivers	2.60	1.50	3.06	0.00	8.00
Middle Chester River	1.30	1.00	1.16	0.00	3.00
Honga River PSU	1.00	0.50	1.41	0.00	4.00
Tuckahoe Creek	1.89	1.00	2.42	0.00	6.00
Pocomoke Sound PSU	0.40	0.00	0.70	0.00	2.00

Table B-24. Total Number of Dewatered Rootwads					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	6.29	7.00	3.45	2.00	13.00
Georges Creek	7.20	6.50	4.78	0.00	15.00
Antietam Creek	5.92	5.50	4.19	0.00	13.00
Lower Monocacy	5.40	4.50	3.35	0.00	12.00
Catoctin Creek	3.08	2.50	3.45	0.00	12.00
Rock Creek/Cabin John Creek	3.70	3.50	1.49	2.00	7.00
Liberty Reservoir	4.13	3.00	4.31	0.00	17.00
St. Marys River	6.00	6.00	2.62	2.00	9.00
Magothy/Severn Rivers	3.40	3.00	3.10	0.00	9.00
Port Tobacco River	5.55	6.00	3.50	0.00	12.00
West Chesapeake Bay	5.50	4.00	4.40	0.00	13.00
Little Gunpowder Falls	5.67	2.00	5.68	0.00	14.00
Broad Creek	2.80	2.00	2.62	0.00	8.00
Lower Elk River PSU	6.50	4.50	6.47	1.00	22.00
Miles/Wye Rivers	3.80	3.00	3.33	0.00	9.00
Middle Chester River	3.80	2.50	4.02	0.00	13.00
Honga River PSU	8.89	5.00	13.64	0.00	43.00
Tuckahoe Creek	2.67	2.00	2.06	0.00	6.00
Pocomoke Sound PSU	11.20	10.00	8.77	0.00	26.00

Table B-25. Total Number of Rootwads					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	7.27	7.00	3.53	2.00	14.00
Georges Creek	8.30	7.50	5.17	1.00	18.00
Antietam Creek	6.67	6.00	4.05	0.00	14.00
Lower Monocacy	7.05	7.50	3.22	1.00	12.00
Catoctin Creek	4.00	3.00	4.33	0.00	14.00
Rock Creek/Cabin John Creek	6.60	6.50	2.22	2.00	10.00
Liberty Reservoir	5.33	4.00	4.32	1.00	17.00
St. Marys River	8.90	9.00	4.07	3.00	15.00
Magothy/Severn Rivers	6.10	5.00	5.07	0.00	15.00
Port Tobacco River	7.50	7.50	4.81	0.00	18.00
West Chesapeake Bay	7.60	7.50	4.53	0.00	16.00
Little Gunpowder Falls	7.11	3.00	5.86	2.00	15.00
Broad Creek	4.60	4.50	2.67	0.00	9.00
Lower Elk River PSU	7.80	6.50	6.73	1.00	23.00
Miles/Wye Rivers	6.40	8.50	4.09	0.00	10.00
Middle Chester River	5.10	4.50	4.01	1.00	13.00
Honga River PSU	10.20	8.00	13.01	0.00	44.00
Tuckahoe Creek	4.10	2.50	4.04	0.00	10.00
Pocomoke Sound PSU	11.60	10.50	9.13	0.00	27.00

Table B-26. Total Nitrogen (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.77	0.56	0.55	0.20	1.68
Georges Creek	0.77	0.60	0.69	0.10	2.65
Antietam Creek	3.02	2.53	2.34	0.12	8.83
Lower Monocacy	2.51	2.62	1.37	0.12	5.01
Catoctin Creek	3.67	3.92	2.22	0.29	7.68
Rock Creek/Cabin John Creek	1.70	1.74	0.80	0.59	3.47
Liberty Reservoir	3.54	3.25	1.55	1.18	6.00
St. Marys River	0.71	0.30	0.62	0.10	1.57
Magothy/Severn Rivers	0.90	0.99	0.43	0.22	1.65
Port Tobacco River	1.64	0.68	1.61	0.10	3.73
West Chesapeake Bay	0.38	0.33	0.16	0.15	0.66
Little Gunpowder Falls	3.67	2.70	3.72	0.91	13.95
Broad Creek	4.00	4.13	1.07	1.43	5.11
Lower Elk River PSU	2.32	2.74	1.31	0.51	3.87
Miles/Wye Rivers	2.71	3.14	1.43	0.65	4.79
Middle Chester River	5.14	4.53	2.24	2.46	10.63
Honga River PSU	5.00	5.42	3.92	0.44	12.31
Tuckahoe Creek	5.71	6.28	2.08	1.21	7.88
Pocomoke Sound PSU	1.04	0.76	0.73	0.43	2.81

Table B-27. Nitrate Nitrogen (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.68	0.42	0.55	0.14	1.57
Georges Creek	0.71	0.55	0.71	0.03	2.62
Antietam Creek	2.69	2.33	1.99	0.05	6.89
Lower Monocacy	2.34	2.23	1.32	0.05	4.86
Catoctin Creek	3.28	3.65	1.90	0.18	6.23
Rock Creek/Cabin John Creek	1.51	1.59	0.84	0.41	3.43
Liberty Reservoir	3.20	3.14	1.50	0.84	5.30
St. Marys River	0.47	0.12	0.55	0.00	1.25
Magothy/Severn Rivers	0.65	0.70	0.42	0.03	1.37
Port Tobacco River	0.96	0.50	0.93	0.01	2.34
West Chesapeake Bay	0.20	0.18	0.15	0.00	0.49
Little Gunpowder Falls	3.29	2.39	3.46	0.29	12.78
Broad Creek	3.82	3.95	1.05	1.20	4.82
Lower Elk River PSU	2.07	2.59	1.45	0.24	3.68
Miles/Wye Rivers	2.13	2.59	1.43	0.00	4.18
Middle Chester River	4.76	4.32	2.25	2.25	10.60
Honga River PSU	4.27	4.60	3.76	0.00	11.41
Tuckahoe Creek	5.21	5.50	2.00	0.78	7.40
Pocomoke Sound PSU	0.44	0.26	0.68	0.00	2.32

Table B-28. Nitrite Nitrogen (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.0004	0.0004	0.0000	0.0004	0.0004
Georges Creek	0.0004	0.0004	0.0001	0.0004	0.0006
Antietam Creek	0.0098	0.0050	0.0100	0.0004	0.0278
Lower Monocacy	0.0040	0.0034	0.0034	0.0004	0.0123
Catoctin Creek	0.0097	0.0074	0.0094	0.0004	0.0301
Rock Creek/Cabin John Creek	0.0066	0.0042	0.0067	0.0030	0.0247
Liberty Reservoir	0.0176	0.0049	0.0384	0.0004	0.1510
St. Marys River	0.0030	0.0004	0.0044	0.0004	0.0121
Magothy/Severn Rivers	0.0013	0.0013	0.0009	0.0004	0.0026
Port Tobacco River	0.0197	0.0024	0.0264	0.0004	0.0703
West Chesapeake Bay	0.0016	0.0004	0.0019	0.0004	0.0062
Little Gunpowder Falls	0.0052	0.0052	0.0042	0.0004	0.0151
Broad Creek	0.0040	0.0047	0.0019	0.0004	0.0055
Lower Elk River PSU	0.0128	0.0111	0.0097	0.0022	0.0333
Miles/Wye Rivers	0.0099	0.0092	0.0078	0.0004	0.0288
Middle Chester River	0.0211	0.0192	0.0166	0.0044	0.0473
Honga River PSU	0.0057	0.0068	0.0044	0.0004	0.0136
Tuckahoe Creek	0.0167	0.0108	0.0162	0.0061	0.0575
Pocomoke Sound PSU	0.0020	0.0004	0.0032	0.0004	0.0101

Table B-29. Ammonia (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.0038	0.0038	0.0014	0.0020	0.0071
Georges Creek	0.0083	0.0022	0.0124	0.0020	0.0407
Antietam Creek	0.0177	0.0082	0.0282	0.0025	0.1117
Lower Monocacy	0.0107	0.0050	0.0217	0.0022	0.1033
Catoctin Creek	0.0653	0.0073	0.1417	0.0024	0.5132
Rock Creek/Cabin John Creek	0.0636	0.0063	0.1831	0.0035	0.5847
Liberty Reservoir	0.0863	0.0394	0.1606	0.0041	0.6318
St. Marys River	0.0717	0.0201	0.0957	0.0051	0.2988
Magothy/Severn Rivers	0.0303	0.0228	0.0254	0.0054	0.0845
Port Tobacco River	0.4121	0.0087	0.5279	0.0037	1.1635
West Chesapeake Bay	0.0446	0.0272	0.0473	0.0097	0.1691
Little Gunpowder Falls	0.0527	0.0336	0.0700	0.0039	0.2084
Broad Creek	0.0233	0.0077	0.0327	0.0023	0.1066
Lower Elk River PSU	0.0414	0.0187	0.0442	0.0041	0.1283
Miles/Wye Rivers	0.0527	0.0303	0.0623	0.0096	0.2249
Middle Chester River	0.0716	0.0286	0.1126	0.0069	0.3751
Honga River PSU	0.0238	0.0177	0.0131	0.0063	0.0434
Tuckahoe Creek	0.0410	0.0171	0.0723	0.0077	0.2454
Pocomoke Sound PSU	0.0524	0.0239	0.0559	0.0140	0.1549

Table B-30. Nitrate nitrogen > 1 mg/L			
PSU	**Percentage of Stream Miles with NO3 > 1 mg/L**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	33.33	11.82	61.62
Georges Creek	10	0.25	44.5
Antietam Creek	71.43	41.9	91.61
Lower Monocacy	85.71	63.66	96.95
Catoctin Creek	85.71	57.19	98.22
Rock Creek/Cabin John Creek	80	44.39	97.48
Liberty Reservoir	93.33	68.05	99.83
St. Marys River	30	6.67	65.25
Magothy/Severn Rivers	10	0.25	44.5
Port Tobacco River	40	12.16	73.76
West Chesapeake Bay	100	69.15	100
Little Gunpowder Falls	90	55.5	99.75
Broad Creek	100	69.15	100
Lower Elk River PSU	55.56	21.2	86.3
Miles/Wye Rivers	70	34.75	93.33
Middle Chester River	100	69.15	100
Honga River PSU	72.73	39.03	93.98
Tuckahoe Creek	90	55.5	99.75
Pocomoke Sound PSU	10	0.25	44.5

Table B-31. Total phosphorus (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.0108	0.0104	0.0065	0.0037	0.0279
Georges Creek	0.0116	0.0101	0.0065	0.0047	0.0212
Antietam Creek	0.0400	0.0349	0.0290	0.0081	0.1036
Lower Monocacy	0.0239	0.0138	0.0234	0.0047	0.1055
Catoctin Creek	0.0969	0.0578	0.1157	0.0188	0.4747
Rock Creek/Cabin John Creek	0.0324	0.0236	0.0267	0.0162	0.1067
Liberty Reservoir	0.0663	0.0414	0.0785	0.0090	0.2887
St. Marys River	0.0172	0.0164	0.0086	0.0040	0.0318
Magothy/Severn Rivers	0.0222	0.0246	0.0109	0.0074	0.0376
Port Tobacco River	0.1344	0.0431	0.1856	0.0121	0.5168
West Chesapeake Bay	0.0609	0.0606	0.0252	0.0087	0.0986
Little Gunpowder Falls	0.0592	0.0326	0.0854	0.0065	0.2897
Broad Creek	0.0237	0.0199	0.0175	0.0044	0.0664
Lower Elk River PSU	0.0753	0.0303	0.0698	0.0190	0.2226
Miles/Wye Rivers	0.0775	0.0722	0.0308	0.0444	0.1424
Middle Chester River	0.0692	0.0487	0.0522	0.0230	0.1831
Honga River PSU	0.0419	0.0503	0.0185	0.0114	0.0652
Tuckahoe Creek	0.0515	0.0379	0.0333	0.0205	0.1146
Pocomoke Sound PSU	0.0833	0.0307	0.1734	0.0089	0.5752

Table B-32. Orthophosphate (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.0025	0.0007	0.0032	0.0007	0.0093
Georges Creek	0.0007	0.0007	0.0000	0.0007	0.0007
Antietam Creek	0.0117	0.0050	0.0144	0.0007	0.0447
Lower Monocacy	0.0079	0.0039	0.0106	0.0007	0.0372
Catoctin Creek	0.0532	0.0318	0.0768	0.0007	0.2989
Rock Creek/Cabin John Creek	0.0052	0.0027	0.0085	0.0007	0.0289
Liberty Reservoir	0.0229	0.0063	0.0394	0.0007	0.1461
St. Marys River	0.0012	0.0007	0.0010	0.0007	0.0035
Magothy/Severn Rivers	0.0038	0.0022	0.0042	0.0007	0.0130
Port Tobacco River	0.0153	0.0156	0.0062	0.0048	0.0219
West Chesapeake Bay	0.0071	0.0059	0.0056	0.0007	0.0209
Little Gunpowder Falls	0.0360	0.0103	0.0835	0.0007	0.2731
Broad Creek	0.0074	0.0029	0.0130	0.0007	0.0436
Lower Elk River PSU	0.0166	0.0079	0.0272	0.0007	0.0905
Miles/Wye Rivers	0.0246	0.0184	0.0148	0.0135	0.0612
Middle Chester River	0.0138	0.0069	0.0233	0.0007	0.0794
Honga River PSU	0.0136	0.0079	0.0144	0.0007	0.0416
Tuckahoe Creek	0.0197	0.0136	0.0262	0.0007	0.0908
Pocomoke Sound PSU	0.0582	0.0061	0.1623	0.0007	0.5199

Table B-33. Dissolved Oxygen (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	8.48	8.40	0.89	7.10	10.10
Georges Creek	8.72	8.50	1.15	7.60	10.80
Antietam Creek	7.70	7.80	0.63	6.50	8.50
Lower Monocacy	8.48	8.70	0.64	7.60	10.10
Catoctin Creek	8.00	7.75	1.05	5.80	9.60
Rock Creek/Cabin John Creek	8.21	8.05	0.95	6.80	10.50
Liberty Reservoir	8.71	8.60	0.90	7.10	11.00
St. Marys River	6.38	7.60	2.18	2.90	8.50
Magothy/Severn Rivers	6.41	7.20	2.84	1.40	9.40
Port Tobacco River	8.00	7.80	0.61	7.30	8.90
West Chesapeake Bay	9.07	9.10	0.40	8.40	9.70
Little Gunpowder Falls	8.82	9.30	1.29	5.80	10.10
Broad Creek	8.67	8.70	0.70	7.50	9.70
Lower Elk River PSU	6.94	7.00	2.43	1.80	10.70
Miles/Wye Rivers	6.61	7.15	2.01	2.20	8.60
Middle Chester River	6.65	6.30	1.24	5.40	9.30
Honga River PSU	4.52	5.30	2.91	0.90	8.60
Tuckahoe Creek	5.88	7.20	2.37	0.80	7.90
Pocomoke Sound PSU	2.88	2.25	2.14	0.80	6.60

Table B-34. Dissolved oxygen < 5 mg/L			
PSU	**Percentage of Stream Miles with DO < 5 mg/L**	**Lower 90% CI**	**Upper 90% CI**
Potomac River L N Br	0	0	21.8
Georges Creek	0	0	30.85
Antietam Creek	0	0	26.46
Lower Monocacy	0	0	16.84
Catoctin Creek	0	0	73.54
Rock Creek/Cabin John Creek	0	0	30.85
Liberty Reservoir	0	0	21.8
St. Marys River	30	6.67	65.25
Magothy/Severn Rivers	20	2.52	55.61
Port Tobacco River	0	0	30.85
West Chesapeake Bay	0	0	30.85
Little Gunpowder Falls	0	0	33.63
Broad Creek	0	0	30.85
Lower Elk River PSU	11.11	0.28	48.25
Miles/Wye Rivers	20	2.52	55.61
Middle Chester River	0	0	30.85
Honga River PSU	45.45	16.75	76.62
Tuckahoe Creek	22.22	2.81	60.01
Pocomoke Sound PSU	80	44.39	97.48

Table B-35. Turbidity (NTUs)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	2.71	2.70	1.66	0.50	6.30
Georges Creek	3.64	3.70	2.61	0.20	8.00
Antietam Creek	5.63	3.05	6.70	0.50	22.00
Lower Monocacy	4.07	3.15	3.37	0.40	15.00
Catoctin Creek	4.18	3.90	1.65	1.90	8.00
Rock Creek/Cabin John Creek	5.77	6.75	2.90	1.60	8.80
Liberty Reservoir	5.25	4.30	5.06	1.00	21.70
St. Marys River	8.76	8.60	3.41	3.30	13.10
Magothy/Severn Rivers	10.26	9.35	6.55	2.00	23.50
Port Tobacco River	6.79	6.15	3.58	3.40	15.40
West Chesapeake Bay	10.18	10.55	2.93	3.70	13.40
Little Gunpowder Falls	3.69	4.00	1.33	2.00	6.30
Broad Creek	6.50	6.40	3.25	1.60	13.00
Lower Elk River PSU	106.51	6.70	313.96	0.70	999.90
Miles/Wye Rivers	9.10	6.95	5.39	3.40	22.20
Middle Chester River	9.66	8.45	5.55	3.00	20.60
Honga River PSU	10.89	3.10	17.09	0.60	54.40
Tuckahoe Creek	8.78	7.80	4.21	4.20	17.00
Pocomoke Sound PSU	37.97	35.00	23.94	5.50	87.10

Table B-36. Sulfate (mg/L)					
PSU	**Mean**	**Median**	**Standard Deviation**	**Minimum**	**Maximum**
Potomac River L N Br	15.41	15.32	1.99	12.15	19.63
Georges Creek	32.74	10.55	62.22	6.39	208.85
Antietam Creek	19.25	14.09	14.66	6.13	65.30
Lower Monocacy	10.18	8.94	4.83	3.48	22.41
Catoctin Creek	20.87	22.22	6.33	9.22	29.70
Rock Creek/Cabin John Creek	14.80	9.87	10.78	4.23	36.91
Liberty Reservoir	7.79	7.38	2.40	5.86	15.10
St. Marys River	9.39	8.71	2.32	6.64	12.96
Magothy/Severn Rivers	22.23	19.70	10.76	8.21	40.21
Port Tobacco River	21.78	20.58	10.05	9.97	38.86
West Chesapeake Bay	19.72	19.57	6.22	9.78	30.23
Little Gunpowder Falls	9.44	7.90	6.47	1.62	26.56
Broad Creek	7.73	8.17	3.13	2.95	13.89
Lower Elk River PSU	12.95	12.37	4.73	6.16	23.84
Miles/Wye Rivers	17.78	17.14	8.27	4.96	34.15
Middle Chester River	10.21	9.83	2.64	6.82	14.84
Honga River PSU	24.48	16.54	18.37	9.83	68.43
Tuckahoe Creek	13.20	13.08	5.73	4.09	23.80
Pocomoke Sound PSU	18.89	18.35	6.74	9.83	28.35

Table B-37. Chloride (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	3.10	1.59	2.41	1.04	9.00
Georges Creek	40.31	2.08	73.28	0.92	180.86
Antietam Creek	29.17	21.91	25.28	4.30	80.95
Lower Monocacy	30.03	19.16	30.93	5.81	148.36
Catoctin Creek	25.39	21.94	19.69	1.97	85.84
Rock Creek/Cabin John Creek	40.94	20.04	39.61	14.98	144.06
Liberty Reservoir	61.66	31.97	81.34	16.77	337.82
St. Marys River	19.87	18.92	9.34	4.85	33.94
Magothy/Severn Rivers	34.95	31.86	15.14	17.73	69.81
Port Tobacco River	32.22	27.56	20.19	3.22	61.04
West Chesapeake Bay	30.35	17.36	39.42	5.21	143.82
Little Gunpowder Falls	20.70	20.18	10.69	2.61	34.73
Broad Creek	23.63	22.96	3.43	18.67	31.65
Lower Elk River PSU	21.59	17.44	13.97	4.31	55.24
Miles/Wye Rivers	18.41	18.54	5.39	7.93	24.16
Middle Chester River	16.19	14.55	3.76	12.16	22.64
Honga River PSU	19.59	20.09	6.59	9.18	33.39
Tuckahoe Creek	18.94	17.32	6.59	11.06	29.79
Pocomoke Sound PSU	15.67	11.81	14.48	5.76	54.93

Table B-38. Dissolved Organic Carbon (mg/L)					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	1.71	1.63	0.70	0.45	2.94
Georges Creek	0.57	0.48	0.39	0.21	1.50
Antietam Creek	1.86	1.70	0.62	1.09	3.03
Lower Monocacy	1.54	1.37	0.83	0.61	3.88
Catoctin Creek	1.96	1.56	1.16	0.76	5.44
Rock Creek/Cabin John Creek	2.66	2.58	0.92	1.12	3.99
Liberty Reservoir	2.30	1.86	1.36	0.84	4.93
St. Marys River	4.03	3.46	1.62	2.44	6.93
Magothy/Severn Rivers	5.97	5.43	1.92	3.90	9.04
Port Tobacco River	3.49	3.40	1.29	2.09	5.96
West Chesapeake Bay	3.55	3.72	0.64	2.73	4.57
Little Gunpowder Falls	2.04	1.68	1.24	1.13	5.20
Broad Creek	1.42	1.19	0.95	0.88	4.07
Lower Elk River PSU	4.98	3.61	3.72	2.38	14.47
Miles/Wye Rivers	12.72	10.23	6.93	7.05	25.73
Middle Chester River	4.44	3.22	4.41	1.43	16.69
Honga River PSU	9.66	6.58	8.04	2.27	29.37
Tuckahoe Creek	6.01	5.20	3.22	2.98	12.33
Pocomoke Sound PSU	18.42	15.03	11.44	7.85	47.86

Table B-39. Percentage Urban Land					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	0.09	0.01	0.25	0.00	0.97
Georges Creek	1.47	0.00	2.39	0.00	5.29
Antietam Creek	2.87	0.14	5.65	0.00	20.05
Lower Monocacy	2.27	1.28	2.59	0.00	9.41
Catoctin Creek	1.07	0.40	1.48	0.00	5.12
Rock Creek/Cabin John Creek	23.89	19.31	21.51	1.49	73.03
Liberty Reservoir	7.42	3.21	11.49	0.00	43.70
St. Marys River	8.70	5.85	9.45	0.00	23.45
Magothy/Severn Rivers	26.73	21.49	14.73	10.08	52.03
Port Tobacco River	21.24	8.97	21.22	1.46	49.87
West Chesapeake Bay	6.30	5.00	5.91	0.08	21.10
Little Gunpowder Falls	1.64	1.02	2.67	0.00	8.88
Broad Creek	1.38	0.32	3.34	0.00	10.86
Lower Elk River PSU	5.86	4.33	4.63	1.05	17.02
Miles/Wye Rivers	2.89	1.95	2.77	0.82	9.19
Middle Chester River	0.96	0.74	0.61	0.41	2.48
Honga River PSU	1.38	0.21	2.71	0.00	8.26
Tuckahoe Creek	1.51	0.48	1.83	0.16	4.88
Pocomoke Sound PSU	0.45	0.00	1.33	0.00	4.22

Table B-40. Percentage Agricultural Land					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	4.13	1.45	4.75	0.00	10.86
Georges Creek	3.90	2.82	3.98	0.00	10.53
Antietam Creek	42.47	35.23	29.48	0.00	95.94
Lower Monocacy	55.19	57.07	20.79	16.97	86.32
Catoctin Creek	61.95	72.93	27.13	0.90	92.73
Rock Creek/Cabin John Creek	42.09	45.60	16.22	5.86	64.64
Liberty Reservoir	70.63	69.84	16.60	32.97	91.74
St. Marys River	18.53	16.66	12.80	0.00	35.65
Magothy/Severn Rivers	21.97	18.32	13.25	9.32	57.09
Port Tobacco River	10.98	11.37	3.00	4.82	16.72
West Chesapeake Bay	15.59	11.65	12.70	2.27	44.31
Little Gunpowder Falls	64.60	62.60	10.04	48.95	82.77
Broad Creek	64.56	71.23	14.54	33.20	78.69
Lower Elk River PSU	65.65	70.08	22.85	7.63	86.17
Miles/Wye Rivers	52.23	54.03	21.04	10.57	89.07
Middle Chester River	88.55	87.96	4.49	80.90	95.78
Honga River PSU	65.82	75.74	23.64	10.27	90.77
Tuckahoe Creek	68.96	67.55	10.86	48.56	83.49
Pocomoke Sound PSU	23.09	25.48	13.49	1.99	39.32

Table B-41. Percentage Forested Land					
PSU	**Mean**	**Median**	**Standard Dev.**	**Minimum**	**Maximum**
Potomac River L N Br	95.72	98.44	4.77	88.97	100.00
Georges Creek	91.69	93.22	7.10	81.85	99.83
Antietam Creek	53.70	60.12	29.30	3.59	100.00
Lower Monocacy	42.11	38.58	21.00	10.53	81.31
Catoctin Creek	36.52	25.53	27.79	3.24	99.10
Rock Creek/Cabin John Creek	32.77	34.16	9.50	20.09	44.99
Liberty Reservoir	21.57	20.84	15.64	2.14	66.96
St. Marys River	69.04	61.60	19.39	44.31	99.79
Magothy/Severn Rivers	50.87	53.56	13.23	31.92	65.47
Port Tobacco River	66.57	75.49	21.87	38.17	87.97
West Chesapeake Bay	77.13	81.43	13.59	52.16	95.37
Little Gunpowder Falls	33.03	35.56	11.27	15.86	50.44
Broad Creek	30.29	26.87	10.32	20.51	49.11
Lower Elk River PSU	28.03	25.05	22.58	0.85	81.26
Miles/Wye Rivers	44.26	40.35	22.03	3.89	87.00
Middle Chester River	9.19	9.54	4.52	3.20	17.56
Honga River PSU	32.77	22.59	23.64	9.06	89.73
Tuckahoe Creek	29.17	29.52	9.50	16.19	44.68
Pocomoke Sound PSU	72.60	70.74	13.65	55.92	90.99

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APPENDIX C
SUMMARY OF TEMPERATURE LOGGER DATA

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SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
ANTI-105-R-2003	18.17	17.24	19.25	22.96	21.47	25.20			
ANTI-106-R-2003	17.93	16.02	20.11	23.25	21.25	17.18			
ANTI-107-R-2003	20.34	19.37	21.48	25.62	23.72	65.67	3.41		
ANTI-111-R-2003									
ANTI-113-R-2003	17.26	16.40	18.18	21.53	20.22	8.29			
ANTI-116-R-2003	19.83	17.79	22.59	28.98	25.59	51.08	12.76		
ANTI-130-R-2003									
ANTI-201-R-2003	17.75	16.06	20.28	27.74	23.06	24.70	2.61		
ANTI-208-R-2003	18.01	16.95	19.19	21.99	20.67	16.99			
ANTI-215-R-2003	20.31	18.41	22.98	32.71	25.18	60.47	15.11	0.02	
ANTI-226-R-2003	20.24	18.71	21.86	25.64	23.91	62.96	6.12		
ANTI-304-R-2003	16.39	15.12	17.63	19.53	18.40				
ANTI-310-R-2003	17.61	16.18	19.08	21.57	20.41	10.84			
ANTI-414-R-2003	19.23	18.39	20.14	23.02	22.02	49.98			
BELK-110-R-2003	16.87	16.21	17.65	22.32	19.04	0.99			
BELK-116-R-2003	18.61	17.56	19.72	23.17	21.50	35.39			
BOHE-105-R-2003	22.78	20.32	25.45	29.23	27.23	84.69	35.39		
BOHE-109-R-2003									No temperature logger - beaver pond
BOHE-113-R-2003	22.65	18.84	27.26	32.62	29.37	76.14	36.07	0.21	
BOHE-114-R-2003									No temperature logger- beaver pond
BROA-101-R-2003	16.65	15.57	18.01	22.17	19.22	0.55			
BROA-103-R-2003	18.84	16.96	20.79	24.06	22.37	38.88	0.03		
BROA-104-R-2003	15.93	14.99	17.05	20.99	18.25	0.21			
BROA-105-R-2003	21.03	19.12	23.03	27.27	24.99	69.70	13.73		
BROA-107-R-2003	15.77	15.14	16.68	22.05	18.13	0.13			
BROA-116-R-2003	18.68	16.62	20.87	24.19	22.49	34.18	0.06		
BROA-306-R-2003	19.19	17.60	20.80	23.88	22.53	43.98			
BROA-312-R-2003	18.41	16.82	20.19	23.09	21.76	27.27			
BROA-318-R-2003	18.29	16.51	20.38	24.61	21.74	26.04	0.23		
BROA-319-R-2003	19.17	17.45	20.99	24.20	22.67	42.93	0.37		
CABJ-102-R-2003	20.69	19.51	22.15	27.07	23.59	69.15	3.59		
CABJ-109-R-2003	20.18	19.07	21.39	25.09	23.02	62.74	1.37		
CATO-103-R-2003	18.81	17.56	20.53	24.74	22.20	35.56	0.12		
CATO-104-R-2003	15.81	15.47	16.27	19.11	18.14				
CATO-106-R-2003	18.54	17.61	19.57	22.64	21.14	35.21			
CATO-109-R-2003	19.88	17.71	22.53	38.11	31.21	44.59	14.56	3.76	
CATO-110-R-2003	18.12	16.36	20.36	24.02	21.83	26.35	0.03		
CATO-111-R-2003	18.91	17.42	20.77	23.41	21.90	31.26			
CATO-121-R-2003									Not sampled in summer
CATO-125-R-2003	18.73	17.89	19.71	23.54	21.69	41.57			

SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
CATO-205-R-2003	18.16	16.74	19.95	28.77	22.49	25.34	0.29		
CATO-208-R-2003	17.65	15.94	19.57	37.83	21.92	16.61	3.26	1.09	
CATO-212-R-2003	19.16	17.72	20.85	25.12	23.40	48.41	2.02		
CATO-214-R-2003	18.52	17.02	20.22	23.19	21.70	32.27			
CATO-301-R-2003	20.38	18.52	22.92	35.36	25.23	62.89	13.51	0.06	
CATO-407-R-2003	21.24	19.34	23.66	29.94	25.79	70.66	20.76		
CHRI-104-R-2003	21.47	18.87	24.52	30.53	26.34	70.46	24.03		
GEOR-102-R-2003	15.46	14.88	16.06	19.91	18.45				
GEOR-103-R-2003	15.46	14.88	16.06	19.91	18.45				
GEOR-104-R-2003	14.77	13.83	16.00	21.93	19.81	2.97			
GEOR-106-R-2003	15.70	14.94	16.63	21.28	19.01	1.15			
GEOR-107-R-2003	15.29	14.50	16.13	21.04	18.77	0.59			
GEOR-114-R-2003	15.14	14.37	15.92	20.15	18.54	0.09			
GEOR-208-R-2003									
GEOR-209-R-2003	16.88	15.70	18.03	22.08	20.28	7.16			
GEOR-211-R-2003	16.59	15.74	17.44	20.72	19.75	2.52			
GEOR-315-R-2003	18.36	16.58	20.63	38.11	23.68	30.56	3.58	1.13	
LIBE-102-R-2003	16.24	15.04	18.13	26.28	18.83	1.08	0.06		
LIBE-105-R-2003	16.25	15.22	17.65	21.47	19.03	0.26			
LIBE-106-R-2003	17.10	16.49	17.77	21.41	19.62	2.12			
LIBE-107-R-2003	16.80	15.74	18.67	25.44	19.76	4.25	0.15		
LIBE-109-R-2003	16.59	15.61	17.76	21.47	19.03	0.45			
LIBE-110-R-2003	16.74	15.44	18.36	20.72	19.58	1.62			
LIBE-111-R-2003	16.51	15.44	17.86	21.06	19.43	1.70			
LIBE-123-R-2003	18.70	17.08	20.82	23.82	22.14	30.87			
LIBE-124-R-2003	16.17	15.14	17.37	21.27	19.31	1.73			
LIBE-127-R-2003	17.60	16.74	18.59	21.27	20.13	5.43			
LIBE-129-R-2003	17.12	15.92	19.15	25.63	19.92	4.67	0.16		
LIBE-204-R-2003	18.68	16.78	20.81	24.36	22.66	35.87	0.48		
LIBE-214-R-2003	18.48	17.13	19.85	22.67	21.33	25.73			
LIBE-218-R-2003	19.92	16.87	23.57	27.97	25.33	51.74	12.34		
LIBE-333-R-2003	19.14	17.91	20.51	24.39	22.34	46.92	0.15		
LICK-121-R-2003	22.67	21.12	24.39	28.17	25.69	86.29	32.13		
LICK-125-R-2003									
LICK-127-R-2003	23.02	21.64	24.75	29.17	26.64	85.25	39.09		
LIEL-312-R-2003	20.43	19.10	21.87	25.07	23.68	68.03	3.72		
LIEL-318-R-2003	21.25	19.97	22.49	25.09	24.39	76.77	10.08		
LIEL-325-R-2003	20.96	19.10	23.23	26.74	25.33	68.42	15.75		
LIGU-102-R-2003	18.30	17.52	19.23	23.32	20.67	22.84			
LIGU-108-R-2003	17.30	16.74	18.14	22.18	20.04	5.73			

SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
LIGU-111-R-2003	16.63	15.26	18.85	22.69	19.73	3.88			
LIGU-113-R-2003	18.09	16.65	19.84	25.08	20.71	15.02	0.03		
LIGU-114-R-2003	16.38	15.56	17.51	22.86	18.43	0.61			
LIGU-115-R-2003	18.05	17.16	19.12	22.46	20.48	10.76			
LIGU-201-R-2003	19.15	17.12	21.28	24.76	23.04	46.50	0.48		
LIGU-217-R-2003	19.18	17.01	21.52	26.82	23.35	45.55	2.86		
LIGU-303-R-2003	19.26	18.16	20.33	23.33	22.16	50.75			
LIGU-307-R-2003	19.77	18.69	20.95	24.89	22.83	58.99	0.69		
LMON-107-R-2003	18.26	16.57	20.17	22.48	21.16	23.89			
LMON-108-R-2003	16.15	15.35	17.21	19.95	18.50				
LMON-109-R-2003	16.38	15.29	18.02	20.73	19.28	1.19			
LMON-112-R-2003	15.77	14.84	16.96	20.31	18.86	0.24			
LMON-113-R-2003	15.16	14.41	16.16	20.00	17.43				
LMON-114-R-2003	19.51	18.46	20.71	25.66	22.08	45.51	0.23		
LMON-118-R-2003	18.03	17.07	19.10	22.97	20.82	20.88			
LMON-119-R-2003	18.35	17.45	19.35	23.18	21.52	31.68			
LMON-121-R-2003	19.92	18.47	21.55	25.15	23.61	58.30	3.02		
LMON-123-R-2003	16.92	15.64	18.83	23.73	20.73	9.86			
LMON-125-R-2003	17.49	16.07	19.26	21.84	20.52	12.00			
LMON-127-R-2003	18.23	17.03	19.69	24.15	20.64	11.11	0.06		
LMON-131-R-2003	16.37	15.68	17.25	21.01	18.91	0.41			
LMON-136-R-2003	17.46	16.87	18.15	21.07	20.09	5.27			
LMON-142-R-2003	18.82	17.89	19.97	23.58	21.91	42.29			
LMON-210-R-2003	18.50	17.57	19.66	23.37	21.53	30.82			
LMON-215-R-2003	18.47	17.50	19.53	22.64	21.47	29.47			
LMON-220-R-2003	18.83	17.67	20.13	22.96	21.96	41.46			
LMON-322-R-2003	18.91	17.73	20.08	23.41	22.06	42.36			
LMON-328-R-2003	19.42	17.26	21.97	36.86	23.35	41.70	2.79	0.48	
LMON-337-R-2003	20.19	18.59	21.86	36.83	23.52	60.65	3.17	0.59	
LOCH-120-S-2003	17.39	16.54	18.32	21.50	20.19	7.04			
LOCK-103-R-2003	21.20	19.70	22.87	29.48	25.01	73.43	11.86		
LOCK-104-R-2003	20.29	19.29	21.34	24.74	23.20	65.95	0.63		
LOCK-108-R-2003	17.76	16.88	18.81	21.51	19.72	3.62			
LOCK-110-R-2003	20.73	19.76	21.80	24.88	23.50	72.65	1.92		
LOCK-118-R-2003	20.92	19.98	21.97	26.09	24.02	72.46	6.41		
LOCK-126-R-2003	20.44	19.60	21.35	23.78	22.77	69.13			
LOCK-128-R-2003	19.02	18.24	19.88	22.49	21.33	38.94			
MAGO-102-R-2003	19.47	18.79	20.58	26.36	22.24	41.32	1.13		
MAGO-104-R-2003	20.57	19.57	21.79	26.06	23.64	67.18	2.99		
MAGO-109-R-2003									No temperature logger deployed

SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
MAGO-111-R-2003	20.72	18.77	23.48	28.23	25.41	65.26	13.50		
MAGO-113-R-2003									No flow in summer
MANO-105-R-2003									No flow in summer
MANO-107-R-2003	22.08	19.70	25.00	32.58	26.83	78.84	25.78	0.02	
MANO-108-R-2003	23.30	21.51	25.76	38.09	29.11	78.68	45.42	1.74	
MANO-111-R-2003	20.54	19.62	21.54	25.66	23.06	70.88	1.34		
MANO-113-R-2003	19.40	18.35	20.60	25.04	22.81	36.12	0.94		
MANO-117-R-2003	19.38	19.03	19.99	34.61	22.07	58.36	0.90	0.03	
MANO-119-R-2003	21.50	20.54	22.73	25.41	24.02	78.18	6.46		
MANO-203-R-2003	22.80	20.90	24.92	29.17	26.65	85.80	32.90		
MICR-101-R-2003									
MICR-102-R-2003	21.97	20.56	23.60	28.39	25.72	84.27	15.86		
MICR-105-R-2003	19.07	17.78	20.67	23.83	22.14	34.32			
MICR-106-R-2003	16.94	16.41	17.60	20.37	18.60	0.27			
MICR-108-R-2003									No temperature logger deployed - beavers
MICR-110-R-2003	18.36	17.46	19.40	29.16	25.40	25.81	8.17		
MICR-111-R-2003	18.59	16.71	21.15	23.67	21.99	26.15			
MICR-112-R-2003	22.41	20.56	24.41	28.44	26.29	84.17	29.14		
MICR-113-R-2003	18.10	17.10	19.20	23.38	20.22	8.87			
MICR-115-R-2003									
MICR-116-R-2003	19.54	18.37	20.83	26.97	23.84	45.07	4.94		
MICR-203-R-2003									
MICR-204-R-2003	21.85	20.32	23.49	27.19	25.09	82.51	16.46		
MICR-214-R-2003									No temperature logger deployed
MILE-118-R-2003	23.45	21.20	26.42	33.24	28.53	84.91	49.14	0.53	
MILE-212-R-2003	21.01	20.00	22.00	25.08	23.71	74.98	3.12		
PCSO-102-R-2003	21.65	20.59	22.70	27.72	24.39	80.44	8.29		
PCSO-118-R-2003	21.65	20.59	22.70	27.72	24.39	80.44	8.29		
PRLN-104-R-2003									Dry in summer
PRLN-105-R-2003	18.92	16.34	23.54	34.12	25.23	38.25	9.80	0.06	
PRLN-107-R-2003	16.63	15.92	17.67	20.67	19.54	2.14			
PRLN-108-R-2003	17.33	16.04	19.12	23.05	20.73	10.45			
PRLN-109-R-2003	15.82	15.17	16.45	20.64	19.18	0.62			
PRLN-110-R-2003									
PRLN-111-R-2003									
PRLN-113-R-2003	15.82	15.17	16.45	20.64	19.18	0.62			
PRLN-115-R-2003	17.60	16.58	18.62	23.12	21.13	18.33			
PRLN-119-R-2003	17.09	16.59	17.59	21.68	20.21	7.35			
PRLN-120-R-2003	19.59	18.07	21.29	25.46	23.38	54.98	2.93		

SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
PRLN-122-R-2003	15.10	14.63	15.63	20.11	18.16	0.03			
PRLN-201-R-2003	18.57	17.36	20.10	24.94	22.71	43.91	0.85		
PRLN-306-R-2003	18.26	17.05	19.55	22.92	21.42	26.18			
PRLN-316-R-2003	18.35	16.78	20.34	24.54	22.66	27.01	0.82		
PRLN-318-R-2003	18.26	17.05	19.55	22.92	21.42	26.18			
PRLN-321-R-2003	17.99	17.00	19.17	22.57	21.24	19.99			
PRLN-626-S-2003	16.86	15.81	17.97	22.22	20.40	8.73			
PTOB-103-R-2003	19.31	18.36	20.37	24.34	22.64	49.94	0.63		
PTOB-104-R-2003	22.15	20.57	24.06	27.76	25.98	77.79	30.92		
PTOB-106-R-2003	19.08	18.23	20.05	23.71	22.37	46.28			
PTOB-108-R-2003	22.55	20.39	24.84	28.57	26.59	78.87	35.29		
PTOB-109-R-2003	20.96	19.56	22.56	25.65	24.27	70.31	8.82		
PTOB-112-R-2003	24.44	18.48	35.03	38.07	38.07	76.76	39.67	16.33	
PTOB-113-R-2003	19.32	18.45	20.25	23.99	22.47	47.39	0.18		
PTOB-118-R-2003									
PTOB-119-R-2003	22.45	20.06	25.94	33.88	26.75	79.13	36.89	0.03	
PTOB-220-R-2003	21.59	20.45	22.81	25.68	24.47	76.92	14.29		
ROCK-105-R-2003	18.23	17.23	19.26	21.85	20.53	14.99			
ROCK-106-R-2003	18.51	17.62	19.49	22.43	20.77	17.11			
ROCK-107-R-2003	18.76	17.89	20.74	29.86	21.79	21.05	1.29		
ROCK-203-R-2003	23.00	22.24	24.02	30.66	26.47	79.00	55.53		
ROCK-204-R-2003	18.85	17.88	19.86	22.72	21.38	32.61			
ROCK-208-R-2003	19.30	18.39	20.28	22.64	21.81	46.12			
ROCK-210-R-2003	19.39	18.47	20.39	22.81	21.98	50.86			
ROCK-211-R-2003									
SEVE-101-R-2003	28.51	24.32	32.59	38.04	35.31	98.00	84.42	22.08	
SEVE-106-R-2003	20.09	19.15	21.07	24.74	23.20	60.26	1.11		
SEVE-108-R-2003	18.88	18.00	19.95	24.76	21.04	29.67	0.03		
SEVE-112-R-2003	20.11	18.94	21.53	25.46	23.39	61.14	2.89		
SEVE-203-R-2003	18.65	17.67	19.70	22.24	20.75	21.60			
SEVE-210-R-2003	18.79	17.12	21.18	26.42	22.29	29.39	0.54		
STCL-051-S-2003	19.66	18.87	20.51	23.78	22.27	57.84			
STMA-104-R-2003	19.64	19.01	20.52	25.09	22.54	49.81	0.75		
STMA-105-R-2003	24.64	23.29	26.24	35.34	28.58	90.83	67.58	0.11	
STMA-106-R-2003	19.87	18.89	21.06	36.29	23.07	49.27	1.28	0.12	
STMA-107-R-2003	19.64	19.01	20.52	25.09	22.54	49.81	0.75		
STMA-112-R-2003	24.64	23.29	26.24	35.34	28.58	90.83	67.58	0.11	
STMA-113-R-2003	20.54	19.73	21.47	24.83	23.28	68.75	1.46		
STMA-115-R-2003	19.71	19.07	20.45	25.01	22.44	59.52	0.15		
STMA-119-R-2003	19.86	19.08	20.76	24.87	22.32	61.56	0.39		

SITEYR	Mean Average Daily Temperature	Mean Minimum Daily Temperature	Mean Maximum Daily Temperature	Absolute Maximum	95th Percentile	Percent Exceedences 20 °C	Percent Exceedences 24 °C	Percent Exceedences 32 °C	Comments
STMA-208-R-2003	20.55	19.85	21.50	26.53	22.91	71.28	0.45		
STMA-218-R-2003	22.18	20.54	24.18	37.37	26.02	81.78	23.52	0.24	
TUCK-101-R-2003	20.60	19.50	21.74	24.27	23.07	70.68	0.26		
TUCK-105-R-2003									
TUCK-107-R-2003	20.20	19.21	21.27	23.90	22.71	63.24	0.15		
TUCK-110-R-2003	20.39	19.20	21.71	24.75	23.21	67.65	0.61		
TUCK-111-R-2003	20.09	18.95	21.37	26.47	22.69	60.57	1.52		
TUCK-113-R-2003	16.43	16.09	16.87	19.23	18.74				
TUCK-115-R-2003	18.53	17.58	19.58	22.82	20.99	18.90			
TUCK-119-R-2003	18.81	16.72	23.18	27.17	23.68	28.54	4.31		
TUCK-203-R-2003	19.87	19.09	20.76	23.58	22.23	55.74			
TUCK-214-R-2003	19.73	18.94	20.63	23.36	22.19	53.76			
TUCK-318-R-2003	21.17	20.41	22.15	25.03	23.82	78.15	4.25		
UELK-215-R-2003	19.49	18.55	20.56	23.29	22.46	51.09			
UELK-308-R-2003	20.85	20.40	21.33	23.95	23.43	71.07	0.39		
WCHE-103-R-2003	18.95	17.84	20.35	23.98	22.12	40.28	0.15		
WCHE-104-R-2003	17.95	17.42	18.59	22.04	20.39	8.77			
WCHE-105-R-2003	19.06	17.92	20.57	25.49	22.57	43.66	0.63		
WCHE-106-R-2003	18.83	17.88	20.02	23.12	21.79	38.38			
WCHE-107-R-2003	19.50	18.13	21.35	25.09	23.38	50.52	2.26		
WCHE-108-R-2003	24.05	22.94	25.27	29.44	27.09	90.45	66.65		
WCHE-111-R-2003	18.31	17.42	19.37	22.53	21.20	26.18			
WCHE-114-R-2003	19.97	18.88	21.23	25.26	22.86	61.56	0.37		
WCHE-115-R-2003	19.39	18.74	20.09	22.36	21.52	52.88			
WCHE-119-R-2003	18.98	18.15	19.92	22.82	21.51	39.72			
WYER-104-R-2003	21.29	19.04	23.90	30.71	25.99	72.12	13.02		
WYER-113-R-2003	20.08	19.26	21.01	25.09	22.52	62.85	0.73		
WYER-119-R-2003	20.66	19.65	21.69	24.88	23.67	72.23	2.54		
WYER-120-R-2003	19.78	18.74	20.95	23.84	22.32	54.08			
WYER-201-R-2003	20.88	19.96	21.83	24.60	23.57	74.98	2.97		
WYER-206-R-2003	19.34	18.29	20.42	23.00	21.67	44.90			
WYER-208-R-2003									
WYER-216-R-2003	20.07	19.30	20.92	24.92	22.69	61.96	0.26		
	210.00								

APPENDIX D
SENTINEL SITE DATA

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Table Appendix D1

SITE	SITENEW	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BKTRFLAG	BLACKWAT
WO-S-038-108-97	NASS-108-S-1997	MILLVILLE CREEK	WORCESTER	1	COASTAL-E	4.4	0.35	3.99	32.9	ORG	83.23	3.25	1.29	2.27	0	1
KE-N-096-102-95	LOCR-102-S-1995	SWAN CREEK	KENT	1	COASTAL-E	5.86	0.12	17.46	20	ORG & AD	70.33	2.75	1.86	1.86	0	1
CN-N-024-113-96	UPCK-113-S-1996	SKELETON CREEK	CAROLINE	1	COASTAL-E	5.95	0.6	15.9	15.9	ORG & AD	61.01	2.75	2.14	2.14	0	1
WI-S-063-220-95	WIRH-220-S-1995	LEONARD POND RUN	WICOMICO	2	COASTAL-E	6.64	2.08	5.28	6	none	56.48	3.25	3	3.13	0	0
QA-N-086-118-95	WYER-118-S-1995	UT WYE EAST RIVER	QUEEN ANNES	1	COASTAL-E	6.8	1.16	13.26	22	none	57.09	3	3.86	3.43	0	0
NEVER SAMPLED	NASS-301-S-2000	NASSAWANGO CREEK	WICOMICO	3	COASTAL-E											
CH-S-033-314-95	MATT-033-S-1995	MATTAWOMAN CREEK	CHARLES	3	COASTAL-W	6.6	0.24	12.84	4	AD	69.63	3.5	2.71	3.11	0	0
CH-S-331-304-95	NANJ-331-S-1995	MILL RUN	CHARLES	3	COASTAL-W	6.46	0.33	11.61	3	AD	81.14	4.75	3.86	4.31	0	0
CH-S-012-114-95	ZEKI-012-S-1995	UT ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.2	0.34	14.82	3	AD	95.19	3.75	4.43	4.09	0	0
CH-S-294-236-97	PAXL-294-S-1997	SWANSON CREEK	CHARLES	2	COASTAL-W	6.85	0.6	14.76	2.5	AD	69.33	4.25	3.57	3.91	0	0
SM-S-051-132-95	STCL-051-S-1995	UT ST CLEMENTS CREEK	ST. MARYS	1	COASTAL-W	6.86	0.2	7.05	4	none	79.26		3.86	3.86	0	0
CA-S-086-209-97	WCHE-086-S-1997	PLUM POINT CREEK	CALVERT	2	COASTAL-W	7.36	0	16.21	3.2	none	74.93	2.75	3.29	3.02	0	0
CH-S-002-207-95	PTOB-002-S-1995	HOGHOLE RUN	CHARLES	2	COASTAL-W	6.62	0.2	10.51	3	AD	83.58	4.5	3.29	3.90	0	0
BA-P-025-102-96	LOCH-102-S-1996	BEAVERDAM RUN	BALTIMORE	1	EPIEDMNT	6.37	1.53	4.81	4.9	AD	56.69	3.44	3.22	3.33	1	0
BA-P-077-322-95	JONE-322-S-1995	NORTH BRANCH	BALTIMORE	3	EPIEDMNT	7.65	1.37	4.77	2	none	52.69	2.56	3.44	3.00	0	0
BA-P-077-315-96	JONE-315-S-1996	NORTH BRANCH	BALTIMORE	3	EPIEDMNT	7.6	1.32	7.36	2.6	none	56.62	3	3.67	3.34	0	0
BA-P-234-109-95	JONE-109-S-1995	DIPPING POND RUN	BALTIMORE	1	EPIEDMNT	6.77	2.51	2.09	1	none	74.33		3.67	3.67	1	0
HO-P-228-119-97	RKGR-119-S-1997	UN TRIB TO PATUXENT RIVER	HOWARD	1	EPIEDMNT	7.69	1.36	7.17	1.5	none	65.92	3.44	4.11	3.78	0	0
BA-P-057-209-96	LOCH-209-S-1996	GREENE BRANCH	BALTIMORE	2	EPIEDMNT	7.43	2.3	9.72	1.4	none	56.58	2.78	3.44	3.11	0	0
BA-P-015-120-96	LOCH-120-S-1996	BAISMANS RUN	BALTIMORE	1	EPIEDMNT	6.97	2.55	3.99	1.1	AD	58.59	1.89	4.33	4.33	1	0
GA-A-159-202-96	SAVA-159-S-1996	MIDDLE FORK	GARRETT	2	HIGHLAND	6.83	0.72	14.05	1	AD	90.35	4.14	3.44	3.79	1	0
GA-A-999-302-96	SAVA-225-S-1996	SAVAGE RIVER	GARRETT	3	HIGHLAND	7.07	0.8	12.03	1.5	AD	83.46	4.14	4.33	4.24	1	0
FR-P-288-133-96	UMON-288-S-1996	TRIB TO HUNTING CREEK	FREDERICK	1	HIGHLAND	7.33	0.56	6.49	1.7	none	88.62	4.14	3.22	3.68	0	0
AL-A-626-216-96	PRLN-626-S-1996	MILL RUN	ALLEGANY	2	HIGHLAND	7.51	0.68	12.89	1.1	none	100.6	2.71	3.67	3.67	1	0
GA-A-432-315-95	YOUG-432-S-1995	BEAR CREEK	GARRETT	3	HIGHLAND	6.96	0.65	9.59	1	AD	76.12	4.14	4.11	4.13	1	0
GA-A-276-106-96	SAVA-276-S-1996	DOUBLE LICK RUN	GARRETT	1	HIGHLAND	6.77	0.49	12.89	0.8	AD	92.12	4.71	3.67	4.19	1	0
AL-A-207-307-95	FIMI-207-S-1995	FIFTEENMILE CREEK	ALLEGANY	3	HIGHLAND	6.91	0.26	10.34	2	AD	89.73	2.71	4.11	3.41	0	0

Table Appendix D2

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
LOCR-102-S-2000	SENTINEL	SWAN CREEK	KENT	1	COASTAL-E	6.02	0.085	4.943	33.182	ORG	85.19	2.75	1.29	1.29	0	1
WIRH-220-S-2000	SENTINEL	LEONARD POND RUN	WICOMICO	2	COASTAL-E	6.23	0.548	1.734	16.032	NONE	51.41	3.25	3.57	3.41	0	1
NASS-108-S-2000	SENTINEL	MILLVILLE CREEK	WORCESTER	1	COASTAL-E	4.41	0.082	3.405	36.061	ORG	77.82	2.00	1.00	1.00	0	1
UPCK-113-S-2000	SENTINEL	SKELETON CREEK	CAROLINE	1	COASTAL-E	5.53	0.117	6.413	28.632	NONE	61.01	2.25	2.71	2.71	0	1
UPCK-115-R-2000		TIDY ISLAND CREEK	CAROLINE	1	COASTAL-E	6.51	0.515	9.530	9.478	ORG	67.55	3.25	1.57	2.41	0	1
UPCK-311-R-2000		FORGE BRANCH	CAROLINE	3	COASTAL-E	6.52	2.851	14.234	7.015	NONE	63.21	4.00	3.29	3.65	0	0
CORS-102-R-2000		KIRBY CREEK	QUEEN ANNES	1	COASTAL-E	6.35	0.164	5.435	17.384	NONE	89.92	1.75	3.29	3.29	0	1
MONI-126-R-2000		MONIE CREEK	SOMERSET	1	COASTAL-E	4.42	0.000	1.594	41.757	AD	92.58	1.75	1.00	1.00	0	1
LOWI-113-R-2000		BEAVERDAM CREEK	WICOMICO	1	COASTAL-E	5.63	0.919	9.971	16.018	ORG	57.25	1.75	1.00	1.00	0	1
WIRH-109-R-2000		LEONARD POND RUN	WICOMICO	1	COASTAL-E	4.31	0.263	5.568	28.823	NONE	93.78	1.00	1.00	1.00	0	1
WIRH-111-R-2000		LEONARD POND RUN	WICOMICO	1	COASTAL-E	5.29	0.931	6.277	18.544	ORG	86.73	2.75	1.29	1.29	0	1
WIRH-114-R-2000		MORRIS BRANCH	WICOMICO	1	COASTAL-E	4.42	0.993	14.345	18.600	ORG	59.23		1.86	1.86	0	1
MATT-033-S-2000	SENTINEL	MATTAWOMAN CREEK	CHARLES	3	COASTAL-W	6.73	0.137	9.472	6.957	NONE	70.03	3.50	3.86	3.68	0	0
NANJ-331-S-2000	SENTINEL	MILL RUN	CHARLES	3	COASTAL-W	6.47	0.164	10.634	3.087	ORG	81.25	3.00	3.57	3.29	0	0
PAXL-294-S-2000	SENTINEL	SWANSON CREEK	CHARLES	2	COASTAL-W	6.70	0.313	14.736	3.106	ORG	69.71	3.00	3.86	3.43	0	0
PTOB-002-S-2000	SENTINEL	HOGHOLE RUN	CHARLES	2	COASTAL-W	6.46	0.000	9.926	3.446	NONE	83.55	4.25	3.57	3.91	0	0
ZEKI-012-S-2000	SENTINEL	ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.52	0.079	7.876	2.566	AD	92.95	3.25	4.14	3.70	0	0
STCL-051-S-2000	SENTINEL	ST CLEMENS CREEK	ST. MARYS	1	COASTAL-W	7.03	0.000	6.053	3.436	NONE	74.93		3.57	3.57	0	0
MATT-210-R-2000		PINEY BRANCH	CHARLES	2	COASTAL-W	6.58	0.259	11.241	3.240	NONE	62.35	3.50	4.14	3.82	0	0
MATT-212-R-2000		MATTAWOMAN CREEK	CHARLES	2	COASTAL-W	7.03	0.188	8.856	2.325	AD	72.47	4.25	4.71	4.48	0	0
MATT-216-R-2000		PINEY BRANCH	CHARLES	2	COASTAL-W	6.35	0.271	11.010	4.679	ORG	61.92	4.25	4.43	4.34	0	0
NANJ-115-R-2000		HILL TOP FORK	CHARLES	1	COASTAL-W	6.09	0.036	3.465	2.811	AD	77.52	3.75	3.00	3.38	0	0
NANJ-205-R-2000		HANCOCK RUN	CHARLES	2	COASTAL-W	5.71	0.000	5.105	10.288	ORG	82.10	1.25	1.86	1.86	0	1
NANJ-308-R-2000		NANJEMOY CREEK	CHARLES	3	COASTAL-W	6.31	0.000	5.094	14.126	AD	87.57	3.50	2.71	3.11	0	1
MATT-320-R-2000		MATTAWOMAN CREEK	CHARLES/ PRINCE GEORGES	3	COASTAL-W	6.60	0.082	8.217	9.655	AD	63.51	3.00	3.57	3.57	0	1
ABPG-108-R-2000		MOSQUITO CREEK	HARFORD	1	COASTAL-W	5.41	0.019	8.964	17.905	ORG	67.59		1.29	1.29	0	1
STMA-104-R-2000		WAREHOUSE RUN	ST. MARYS	1	COASTAL-W	6.76	0.452	10.834	4.242	NONE	81.77	4.75	4.43	4.59	0	0
STMA-110-R-2000		BROOM CREEK	ST. MARYS	1	COASTAL-W	6.32	0.528	10.397	2.314	AD	75.85		4.14	4.14	0	0
STMA-113-R-2000		ST MARY'S RIVER	ST. MARYS	1	COASTAL-W	6.15	0.326	14.553	3.457	NONE	65.97	4.00	3.29	3.65	0	0
STMA-116-R-2000		ST GEORGE CREEK	ST. MARYS	1	COASTAL-W	4.80	0.000	12.645	33.384	AD	76.63		1.00	1.00	0	1
STMA-202-R-2000		ST MARY'S RIVER	ST. MARYS	2	COASTAL-W	6.23	0.217	5.040	8.928	ORG	73.03	3.50	2.43	2.97	0	1
STMA-306-R-2000		ST MARY'S RIVER	ST. MARYS	3	COASTAL-W	6.45	0.306	6.239	5.887	ORG	69.39	3.25	3.86	3.56	0	0
JONE-109-S-2000	SENTINEL	DIPPING POND RUN	BALTIMORE	1	EPIEDMNT	6.41	2.386	2.660	0.792	NONE	76.78		4.11	4.11	0	0
JONE-315-S-2000	SENTINEL	NORTH BR JONES FALLS	BALTIMORE	3	EPIEDMNT	7.52	1.066	6.174	2.007	NONE	56.29	3.22	4.33	3.78	0	0
JONE-322-S-2000	SENTINEL	NORTH BR JONES FALLS	BALTIMORE	3	EPIEDMNT	7.53	0.931	6.745	2.000	NONE	52.35	2.78	4.33	3.56	0	0
LOCH-102-S-2000	SENTINEL	BEAVERDAM RUN	BALTIMORE	1	EPIEDMNT	6.32	2.326	2.360	1.779	AD	56.60	3.00	4.33	4.33	1	0
LOCH-120-S-2000	SENTINEL	BAISMAN RUN	BALTIMORE	1	EPIEDMNT	7.01	1.075	4.918	0.988	AD	62.99	2.78	3.22	3.22	1	0
LOCH-209-S-2000	SENTINEL	GREENE BRANCH	BALTIMORE	2	EPIEDMNT	7.54	1.745	10.518	1.229	NONE	53.91	3.22	3.67	3.45	0	0
RKGR-119-S-2000	SENTINEL	PATUXENT RIVER	HOWARD	1	EPIEDMNT	7.49	1.205	7.586	1.564	AD	66.76	3.89	3.44	3.67	0	0
LIBE-101-C-2000		TIMBER RUN	BALTIMORE	1	EPIEDMNT	7.03	1.049	5.407	1.129	NONE	77.51	3.89	5.00	4.45	1	0
LIBE-102-C-2000		TIMBER RUN	BALTIMORE	1	EPIEDMNT	6.97	1.126	4.826	0.935	NONE	76.96	4.33	4.11	4.22	1	0
LIBE-103-C-2000		COOKS BRANCH	BALTIMORE	1	EPIEDMNT	7.43	1.052	8.377	1.443	NONE	73.15	3.89	4.33	4.11	1	0
LIBE-117-R-2000		LIBERTY RESERVOIR	BALTIMORE	1	EPIEDMNT	6.85	1.049	7.573	1.535	NONE	71.52	3.00	4.11	3.56	0	0
LIBE-204-C-2000		COOKS BRANCH	BALTIMORE	2	EPIEDMNT	7.39	1.003	7.917	1.116	NONE	74.31	3.89	4.56	4.23	1	0
LIBE-203-R-2000		MORGAN RUN	CARROLL	2	EPIEDMNT	7.41	3.749	5.832	1.304	NONE	95.38	4.11	3.44	3.78	0	0
SBPA-329-R-2000		GILLIS FALLS	CARROLL	3	EPIEDMNT	7.56	3.279	4.778	1.317	NONE	76.57	4.11	4.11	4.11	0	0
FURN-101-C-2000		WINCH RUN (BUCK SWAMP CREEK)	CECIL	1	EPIEDMNT	6.66	0.509	4.055	2.224	ORG	86.36	3.89	4.56	4.23	0	0
SWAN-104-R-2000		CARSINS RUN	HARFORD	1	EPIEDMNT	7.39	0.439	6.668	6.159	AD	61.11	3.67	4.11	3.89	0	0
SWAN-105-R-2000		CARSINS RUN	HARFORD	1	EPIEDMNT	7.42	0.582	9.060	4.241	NONE	64.92	3.67	4.11	3.89	0	0
BRIG-212-R-2000		CABIN BRANCH	HOWARD	2	EPIEDMNT	7.08	2.895	4.721	1.678	NONE	61.26	3.22	3.89	3.56	0	0
PATL-222-R-2000		DEEP RUN	HOWARD	2	EPIEDMNT	7.73	0.265	23.172	2.410	NONE	50.65	4.11	3.67	3.89	0	0
FIMI-207-S-2000	SENTINEL	FIFTEENMILE CREEK	ALLEGANY	3	HIGHLAND	7.09	0.196	9.015	2.211	AD	89.69	3.29	3.44	3.37	0	0

Table Appendix D2

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
PRLN-626-S-2000	SENTINEL	MILL RUN	ALLEGANY	2	HIGHLAND	7.56	0.443	13.174	0.987	NONE	100.00	3.57	4.56	4.07	1	0
UMON-288-S-2000	SENTINEL	HIGH RUN	FREDERICK	1	HIGHLAND	6.52	0.163	3.653	1.603	NONE	81.63	2.43	4.33	4.33	1	0
SAVA-159-S-2000	SENTINEL	MIDDLE FORK RUN	GARRETT	2	HIGHLAND	7.03	0.425	13.162	0.789	AD	90.21	4.43	4.33	4.38	1	0
SAVA-225-S-2000	SENTINEL	SAVAGE RIVER	GARRETT	3	HIGHLAND	7.26	0.452	11.607	2.449	NONE	83.87	3.57	4.78	4.18	1	0
SAVA-276-S-2000	SENTINEL	DOUBLE LICK RUN	GARRETT	1	HIGHLAND	6.75	0.329	12.110	0.700	AD	92.64	4.14	4.33	4.24	1	0
YOUG-432-S-2000	SENTINEL	BEAR CREEK	GARRETT	3	HIGHLAND	7.01	0.788	9.773	2.329	AD	76.25	3.86	4.78	4.32	1	0
FIMI-103-R-2000		FIFTEENMILE CREEK	ALLEGANY	1	HIGHLAND	6.48	0.095	7.828	1.713	AD	100.00		3.44	3.44	0	0
FIMI-105-R-2000		SIDELING HILL CREEK	ALLEGANY	1	HIGHLAND	6.58	0.145	11.058	1.273	AD	77.19		4.11	4.11	0	0
FIMI-108-R-2000		FIFTEENMILE CREEK	ALLEGANY	1	HIGHLAND	6.91	0.348	7.919	1.769	AD	70.83		3.67	3.67	0	0
FIMI-202-R-2000		BLACK SULFER RUN	ALLEGANY	2	HIGHLAND	7.03	0.259	9.994	1.300	AD	97.12	3.29	3.89	3.59	0	0
FIMI-401-R-2000		FIFTEENMILE CREEK	ALLEGANY	4	HIGHLAND	7.15	0.233	11.613	1.473	NONE	92.27	4.71	4.11	4.41	0	0
FIMI-404-R-2000		FIFTEENMILE CREEK	ALLEGANY	4	HIGHLAND	7.29	0.118	11.672	1.319	NONE	92.85	4.43	2.56	3.50	0	0
FIMI-407-R-2000		FIFTEENMILE CREEK	ALLEGANY	4	HIGHLAND	7.40	0.122	11.725	1.331	AD	92.80	4.71	3.44	4.08	0	0
TOWN-104-R-2000		SAWPIT RUN	ALLEGANY	1	HIGHLAND	6.68	0.000	12.234	2.050	NONE	100.00		3.44	3.44	0	0
TOWN-408-R-2000		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.54	0.219	12.094	1.693	AD	82.58	3.29	4.33	3.81	0	0
TOWN-409-R-2000		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.64	0.296	14.091	1.771	NONE	81.85	4.43	4.78	4.61	0	0
TOWN-412-R-2000		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.86	0.303	14.024	1.766	NONE	81.87	5.00	4.33	4.67	0	0
WILL-102-C-2000		HAZEN RUN	ALLEGANY	1	HIGHLAND	7.94	0.549	14.184	1.598	ORG	98.59	4.43	3.22	3.83	1	0
LMON-136-T-2000		UT LAUREL BRANCH	FREDERICK	1	HIGHLAND	6.93	0.445	10.025	1.478	NONE	57.74		3.22	3.22	0	0
UMON-101-C-2000		LITTLE FISHING CREEK	FREDERICK	1	HIGHLAND	6.70	0.106	1.554	0.841	NONE	99.86	4.43	3.67	4.05	1	0
UMON-119-R-2000		BUZZARD BRANCH	FREDERICK	1	HIGHLAND	7.05	0.139	5.757	1.841	NONE	99.33	2.71	3.67	3.67	1	0
UMON-207-R-2000		LITTLE HUNTING CREEK	FREDERICK	2	HIGHLAND	6.98	0.225	6.246	1.220	AD	75.73	3.86	3.00	3.43	0	0
UMON-221-R-2000		HUNTING CREEK	FREDERICK	2	HIGHLAND	7.42	0.462	7.761	5.658	NONE	80.54	3.86	4.33	4.10	0	0
UMON-229-R-2000		MUDDY RUN	FREDERICK	2	HIGHLAND	7.23	0.309	4.553	1.715	NONE	94.11	3.86	3.00	3.43	0	0
UMON-230-R-2000		HUNTING CREEK	FREDERICK	2	HIGHLAND	7.23	0.411	7.500	2.170	NONE	89.66	3.57	4.33	3.95	0	0
UMON-304-R-2000		FRIENDS CREEK	FREDERICK	3	HIGHLAND	7.75	0.701	13.875	2.199	AD	69.89	4.43	4.11	4.27	0	0
UMON-322-R-2000		HUNTING CREEK	FREDERICK	3	HIGHLAND	7.61	0.455	7.555	2.484	NONE	82.69	4.14	4.11	4.13	0	0
UMON-413-R-2000		TOMS CREEK	FREDERICK	4	HIGHLAND	7.74	0.657	12.358	2.547	NONE	77.24	3.57	3.22	3.40	0	0
CASS-104-R-2000		SOUTH BR CASSELMAN RIVER	GARRETT	1	HIGHLAND	7.02	0.488	22.479	1.402	NONE	78.28	3.86	4.78	4.32	1	0
CASS-110-R-2000		TWOMILE RUN	GARRETT	1	HIGHLAND	7.41	1.562	17.228	1.378	AD	54.96	4.43	3.67	4.05	1	0
CASS-307-R-2000		CASSELMAN RIVER	GARRETT	3	HIGHLAND	6.93	0.400	19.929	1.463	AD	78.80	3.57	4.78	4.18	0	0
LYOU-101-C-2000		BLACK RUN	GARRETT	1	HIGHLAND	7.03	0.267	8.418	7.030	NONE	96.31	4.43	4.78	4.61	1	0
SAVA-101-C-2000		MONROE RUN	GARRETT	1	HIGHLAND	7.20	0.281	12.337	1.066	NONE	96.12	4.14	4.78	4.46	1	0
SAVA-203-C-2000		POPLAR LICK RUN	GARRETT	2	HIGHLAND	7.14	0.324	10.617	1.152	AD	93.62	4.14	4.78	4.46	1	0
SAVA-204-C-2000		CRABTREE CREEK	GARRETT	2	HIGHLAND	7.55	0.392	13.202	0.905	AD	87.35	5.00	5.00	5.00	1	0
YOUG-202-C-2000		POPLAR LICK RUN	GARRETT	2	HIGHLAND	7.50	0.405	10.539	1.052	AD	92.03	4.43	3.89	4.16	1	0
YOUG-203-C-2000		PUZZLEY RUN	GARRETT	2	HIGHLAND	7.21	0.805	13.966	0.906	NONE	72.50	4.14	4.78	4.46	1	0
ANTI-101-C-2000		EDGEMONT RESERVOIR	WASHINGTON	1	HIGHLAND	7.54	0.463	10.654	1.760	NONE	87.71	2.14	3.67	3.67	1	0
LTON-108-R-2000		LITTLE TONOLOWAY CREEK	WASHINGTON	1	HIGHLAND	8.11	0.483	19.937	2.735	NONE	60.12	3.00	3.22	3.11	0	0
LTON-113-R-2000		LITTLE TONOLOWAY CREEK	WASHINGTON	1	HIGHLAND	8.28	0.351	21.501	2.358	AD	54.74	3.00	3.22	3.11	0	0

Table Appendix D3

SITE	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
LOCR-102-S-2000	2000	SWAN CREEK	1	COASTAL-E	6.02	0.085	4.943	33.182	ORG	85.19	2.75	1.29	1.29	0	1
NASS-108-S-2000	2000	MILLVILLE CREEK	1	COASTAL-E	4.41	0.082	3.405	36.061	ORG	77.82	2.00	1.00	1.00	0	1
UPCK-113-S-2000	2000	SKELETON CREEK	1	COASTAL-E	5.53	0.117	6.413	28.632	NONE	61.01	2.25	2.71	2.71	0	1
WIRH-220-S-2000	2000	LEONARD POND RUN	2	COASTAL-E	6.23	0.548	1.734	16.032	NONE	51.41	3.25	3.57	3.41	0	1
CORS-102-R-2000	2000	KIRBY CREEK	1	COASTAL-E	6.35	0.164	5.435	17.384	NONE	89.92	1.75	3.29	3.29	0	1
NASS-302-S-2001		NASSAWANGO CREEK	3	COASTAL-E											
MATT-033-S-2000	2000	MATTAWOMAN CREEK	3	COASTAL-W	6.73	0.137	9.472	6.957	NONE	70.03	3.50	3.86	3.68	0	0
NANJ-331-S-2000	2000	MILL RUN	3	COASTAL-W	6.47	0.164	10.634	3.087	ORG	81.25	3.00	3.57	3.29	0	0
PAXL-294-S-2000	2000	SWANSON CREEK	2	COASTAL-W	6.70	0.313	14.736	3.106	ORG	69.71	3.00	3.86	3.43	0	0
PTOB-002-S-2000	2000	HOGHOLE RUN	2	COASTAL-W	6.46	0.000	9.926	3.446	NONE	83.55	4.25	3.57	3.91	0	0
STCL-051-S-2000	2000	UT ST CLEMENTS CREEK	1	COASTAL-W	7.03	0.000	6.053	3.436	NONE	74.93		3.57	3.57	0	0
WCHE-086-S-2000	2000	PLUM POINT CREEK	2	COASTAL-W	7.07	0.061	14.256	5.199	NONE	74.61	2.00	2.14	2.07	0	0
ZEKI-012-S-2000	2000	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.52	0.079	7.876	2.566	AD	92.95	3.25	4.14	3.70	0	0
JONE-109-S-2000	2000	DIPPING POND RUN	1	EPIEDMNT	6.41	2.386	2.660	0.792	NONE	76.78		4.11	4.11	0	0
JONE-315-S-2000	2000	NORTH BR JONES FALLS	3	EPIEDMNT	7.52	1.066	6.174	2.007	NONE	56.29	3.22	4.33	3.78	0	0
LOCH-120-S-2000	2000	BAISMANS RUN	1	EPIEDMNT	7.01	1.075	4.918	0.988	AD	62.99	2.78	3.22	3.22	1	0
RKGR-119-S-2000	2000	UN TRIB TO PATUXENT R	1	EPIEDMNT	7.49	1.205	7.586	1.564	AD	66.76	3.89	3.44	3.67	0	0
FURN-101-C-2000	2000	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.66	0.509	4.055	2.224	ORG	86.36	3.89	4.56	4.23	0	0
LIBE-102-C-2000	2000	TIMBER RUN	1	EPIEDMNT	6.97	1.126	4.826	0.935	NONE	76.96	4.33	4.11	4.22	1	0
FIMI-207-S-2000	2000	FIFTEENMILE CREEK	3	HIGHLAND	7.09	0.196	9.015	2.211	AD	89.69	3.29	3.44	3.37	0	0
PRLN-626-S-2000	2000	MILL RUN	2	HIGHLAND	7.56	0.443	13.174	0.987	NONE	100.00	3.57	4.56	4.07	1	0
SAVA-159-S-2000	2000	MIDDLE FORK RUN	2	HIGHLAND	7.03	0.425	13.162	0.789	AD	90.21	4.43	4.33	4.38	1	0
SAVA-225-S-2000	2000	SAVAGE RIVER	3	HIGHLAND	7.26	0.452	11.607	2.449	NONE	83.87	3.57	4.78	4.18	1	0
SAVA-276-S-2000	2000	DOUBLE LICK RUN	1	HIGHLAND	6.75	0.329	12.110	0.700	AD	92.64	4.14	4.33	4.24	1	0
UMON-288-S-2000	2000	TRIB TO HUNTING CREEK	1	HIGHLAND	6.52	0.163	3.653	1.603	NONE	81.63	2.43	4.33	4.33	1	0
YOUG-432-S-2000	2000	BEAR CREEK	3	HIGHLAND	7.01	0.788	9.773	2.329	AD	76.25	3.86	4.78	4.32	1	0

Table Appendix D4

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
CORS-102-S-2001	SENTINEL	UT EMORY CR	QUEEN ANNES	1	COASTAL-E	6.56	0.440	8.241	8.682	ORG & AD	89.92	1.75	2.71	2.71	0	1
LOCR-102-S-2001	SENTINEL	SWAN CR	KENT	1	COASTAL-E	5.92	0.169	7.821	20.150		85.19	2.75	1.86	1.86	0	1
NASS-108-S-2001	SENTINEL	MILLVILLE CR	WORCESTER	1	COASTAL-E	4.36	0.182	5.479	27.625	ORG	77.82	2.25	1.29	1.29	0	1
NASS-302-S-2001	SENTINEL	NASSAWANGO CR	WORCESTER	3	COASTAL-E	6.25	0.252	7.297	12.198	ORG & AD	71.66		3.29	3.29	0	1
UPCK-113-S-2001	SENTINEL	UT CHOPTANK R	CAROLINE	1	COASTAL-E	6.12	0.303	10.977	17.414	ORG & AD	61.00	2.50	2.71	2.71	0	1
WIRH-220-S-2001	SENTINEL	LEONARD MILL RUN	WICOMICO	2	COASTAL-E	6.76	3.860	5.137	3.652	none	51.41	3.25	4.43	3.84	0	0
DIVI-104-R-2001		TONY CR	SOMERSET	1	COASTAL-E	4.89	0.513	9.007	14.035	ORG & AD	84.79	3.25	1.57	2.41	0	1
DIVI-110-R-2001		DIVIDING CR	WICOMICO	1	COASTAL-E	5.84	0.305	10.228	16.090	ORG & AD	77.75		2.14	2.14	0	1
DIVI-112-R-2001		POLLITTS BR	SOMERSET	1	COASTAL-E	6.08	0.255	7.423	5.942	AD	63.13	3.75	3.29	3.52	0	0
DIVI-119-R-2001		MILLER BR	WORCESTER	1	COASTAL-E	4.17	0.001	9.196	19.677	ORG & AD	88.53	1.00	1.86	1.86	0	1
DIVI-218-R-2001		DIVIDING CR	WORCESTER	2	COASTAL-E	6.16	1.033	8.946	9.512	ORG & AD	72.45	3.50	4.14	3.82	0	1
NASS-217-R-2001		NASSAWANGO CR	WICOMICO	2	COASTAL-E	6.63	1.246	12.018	9.984	ORG & AD	59.62	3.25	3.86	3.55	0	1
UPPC-117-R-2001		FIVEMILE BR	WORCESTER	1	COASTAL-E	5.00	0.098	16.598	32.876	ORG & AD	91.34	1.00	2.71	2.71	0	1
MATT-033-S-2001	SENTINEL	MATTAWOMAN CR	CHARLES	3	COASTAL-W	6.72	0.115	11.134	3.497	AD	69.69	3.00	3.29	3.14	0	0
NANJ-331-S-2001	SENTINEL	MILL RUN	CHARLES	3	COASTAL-W	6.66	0.236	10.836	1.649	AD	81.36	2.50	4.71	3.61	0	0
PAXL-294-S-2001	SENTINEL	SWANSON CR	CHARLES	2	COASTAL-W	6.94	0.424	14.800	1.864	AD	69.82	3.00	4.14	3.57	0	0
PTOB-002-S-2001	SENTINEL	HOGHOLE RUN	CHARLES	2	COASTAL-W	6.59	0.001	9.788	1.523	AD	82.68	4.25	3.86	4.05	0	0
STCL-051-S-2001	SENTINEL	ST CLEMENTS UT	ST. MARY'S	1	COASTAL-W	6.96	0.001	6.558	2.560	none	74.93		4.71	4.71	0	0
ZEKI-012-S-2001	SENTINEL	UT ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.66	0.214	7.363	1.740	AD	93.04	3.50	4.14	3.82	0	0
GILB-101-R-2001		LANCASTER RUN	CHARLES	1	COASTAL-W	6.64	1.084	11.141	1.881	AD	55.01	2.75	3.57	3.16	0	0
GILB-111-R-2001		ODEN RUN	CHARLES	1	COASTAL-W	6.91	1.575	17.181	1.740	AD	52.20	2.75	4.71	3.73	0	0
GILB-115-R-2001		SMOOTS POND RUN	CHARLES	1	COASTAL-W	6.55	1.517	11.832	3.223	AD	54.49	5.00	2.71	3.86	0	0
GILB-306-R-2001		GILBERT SWAMP RUN	CHARLES	3	COASTAL-W	6.92	0.732	12.806	3.512	AD	60.85	3.00	3.86	3.43	0	0
GILB-307-R-2001		GILBERT SWAMP RUN	CHARLES	3	COASTAL-W	6.74	0.739	12.497	3.007	none	62.58	3.50	3.86	3.68	0	0
PAXM-106-R-2001		UT MATAPONI CR	PRINCE GEORGES	1	COASTAL-W	6.26	0.376	19.080	3.383	AD	62.95	4.00	4.14	4.07	0	0
PAXM-211-R-2001		MATAPONI CR	PRINCE GEORGES	2	COASTAL-W	6.64	0.705	32.195	3.087	AD	52.07	3.00	3.57	3.29	0	0
PRUT-117-R-2001		UT POTOMAC RIVER	CHARLES	1	COASTAL-W	4.91	0.001	14.433	9.081	ORG & AD	96.12		1.57	1.57	0	1
ZEKI-104-R-2001		UT ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.64	0.272	7.132	1.766	AD	93.77	3.75	3.86	3.80	0	0
ZEKI-109-R-2001		UT ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.68	1.122	12.425	2.562	AD	53.82	2.75	3.29	3.02	0	0
ZEKI-114-R-2001		UT ZEKIAH SWAMP RUN	CHARLES	1	COASTAL-W	6.63	0.998	12.072	2.475	AD	54.49	3.00	3.86	3.43	0	0
ZEKI-215-R-2001		UT ZEKIAH SWAMP RUN	CHARLES	2	COASTAL-W	6.66	0.926	13.173	1.824	AD	56.72	4.75	4.14	4.45	0	0
ZEKI-302-R-2001		ZEKIAH SWAMP RUN	CHARLES	3	COASTAL-W	6.11	0.320	11.180	3.581	AD	59.46	4.25	3.57	3.91	0	0
ZEKI-305-R-2001		ZEKIAH SWAMP RUN	CHARLES	3	COASTAL-W	6.55	0.356	10.359	4.606	AD	58.98	4.25	4.71	4.48	0	0
ZEKI-307-R-2001		ZEKIAH SWAMP RUN	CHARLES	3	COASTAL-W	6.12	0.307	8.668	3.572	AD	73.04	4.00	3.86	3.93	0	0
ZEKI-312-R-2001		ZEKIAH SWAMP RUN	CHARLES	3	COASTAL-W	6.73	0.246	10.686	3.740	AD	62.78	3.75	3.57	3.66	0	0
FURN-101-S-2001	SENTINEL	WINCH RUN (BUCK SWAMP CR)	CECIL	1	EPIEDMNT	6.78	0.622	4.882	3.074	AD	86.46	3.89	4.11	4.00	0	0
JONE-109-S-2001	SENTINEL	UT DIPPING POND RUN	BALTIMORE	1	EPIEDMNT	6.67	2.921	1.138	1.091	none	76.78		4.11	4.11	0	0
JONE-315-S-2001	SENTINEL	NORTH BR JONES FALLS	BALTIMORE	3	EPIEDMNT	8.20	1.522	4.298	1.134	none	55.31	3.44	3.00	3.22	0	0
LIBE-102-S-2001	SENTINEL	TIMBER RUN	BALTIMORE	1	EPIEDMNT	7.14	1.272	4.273	1.140	none	74.67	3.22	3.44	3.33	1	0
LOCH-120-S-2001	SENTINEL	BAISMAN RUN	BALTIMORE	1	EPIEDMNT	7.14	1.658	2.888	0.790	AD	59.81	2.56	4.33	4.33	1	0
RKGR-119-S-2001	SENTINEL	UT PATUXENT R	HOWARD	1	EPIEDMNT	6.81	1.648	5.922	1.077	none	65.20	3.44	4.11	3.78	0	0
DEER-113-R-2001		WET STONE BR	HARFORD	1	EPIEDMNT	7.07	2.137	3.491	1.052	AD	60.24	4.33	4.78	4.56	1	0
LIBE-103-C-2001		COOKS BR	BALTIMORE	1	EPIEDMNT	7.38	1.090	7.786	1.238	none	75.53	3.22	5.00	4.11	1	0
LIBE-204-C-2001		COOKS BR	BALTIMORE	2	EPIEDMNT	7.35	1.119	7.702	0.952	none	74.40	3.67	4.33	4.00	1	0
LIGU-105-R-2001		UT LITTLE GUNPOWDER FALLS	HARFORD	1	EPIEDMNT	7.74	2.848	11.077	1.165	none	50.70		4.56	4.56	0	0
NEAS-107-R-2001		UT STONY RUN	CECIL	1	EPIEDMNT	6.86	0.409	7.112	2.510	AD	70.07	3.22	3.89	3.56	0	0
FIMI-207-S-2001	SENTINEL	FIFTEENMILE CR	ALLEGANY	3	HIGHLAND	7.10	0.402	8.793	0.898	AD	89.51	3.57	3.44	3.51	0	0
PRLN-626-S-2001	SENTINEL	MILL RUN	ALLEGANY	2	HIGHLAND	7.67	0.841	12.188	0.879	none	100.00	3.86	4.11	3.98	1	0
SAVA-159-S-2001	SENTINEL	MIDDLEFORK RUN	GARRETT	2	HIGHLAND	7.12	0.774	12.592	0.548	AD	90.15	4.14	4.33	4.24	1	0
SAVA-225-S-2001	SENTINEL	SAVAGE R	GARRETT	3	HIGHLAND	7.22	0.917	10.399	1.173	AD	83.84	4.14	3.67	3.90	1	0
SAVA-276-S-2001	SENTINEL	DOUBLE LICK RUN	GARRETT	1	HIGHLAND	6.76	0.542	10.703	0.284	AD	91.01	4.14	3.89	4.02	1	0
UMON-288-S-2001	SENTINEL	UT HUNTING CR	FREDERICK	1	HIGHLAND	6.52	0.396	3.656	0.678	AD	87.89	2.43	4.33	4.33	1	0
YOUG-432-S-2001	SENTINEL	BEAR CR	GARRETT	3	HIGHLAND	6.47	1.023	8.589	0.956	AD	76.35	4.14	4.56	4.35	1	0

Table Appendix D4

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
ANTI-101-C-2001		UT EDGEWOOD RESERVOIR	WASHINGTON	1	HIGHLAND	7.50	0.867	10.479	1.331	none	86.55	2.14	5.00	5.00	1	0
PRAL-106-R-2001		UT POTOMAC R	ALLEGANY	1	HIGHLAND	6.77	0.371	14.279	1.879	AD	100.00		3.44	3.44		
PRUN-102-R-2001		McMILLAN FORK OF SHIELDS RUN	GARRETT	1	HIGHLAND	7.07	0.713	27.252	0.677	none	89.22	1.57	4.56	4.56	1	0
PRUN-103-R-2001		FOLLY RUN	GARRETT	1	HIGHLAND	6.69	0.685	11.055	0.496	AD	96.47	3.57	3.44	3.51	1	0
PRUN-107-R-2001		FOLLY RUN	GARRETT	1	HIGHLAND	6.63	0.609	11.047	0.622	AD	96.63	3.00	4.11	3.56	1	0
SAVA-101-C-2001		MONROE RUN	GARRETT	1	HIGHLAND	7.13	0.605	11.717	0.532	AD	95.88	4.43	4.56	4.49	0	0
SAVA-202-C-2001		POPLAR LICK RUN	GARRETT	2	HIGHLAND	6.78	0.602	7.756	0.986	AD	91.54	3.29	3.67	3.48	1	0
SAVA-203-C-2001		POPLAR LICK RUN	GARRETT	2	HIGHLAND	6.90	0.608	10.027	0.631	AD	93.35	4.43	4.56	4.49	1	0
SAVA-204-C-2001		CRABTREE CR	GARRETT	2	HIGHLAND	7.37	0.707	12.914	0.579	none	89.30	3.86	4.33	4.10	1	0
SIDE-109-R-2001		UT SIDELING HILL CR	ALLEGANY	1	HIGHLAND	7.46	1.351	14.993	1.830	none	94.23		3.44	3.44	0	0
SIDE-402-R-2001		SIDELING HILL CR	ALLEGANY	4	HIGHLAND	7.24	0.621	11.173	1.589	AD	76.32	4.43	4.11	4.27	0	0
SIDE-405-R-2001		SIDELING HILL CR	WASHINGTON	4	HIGHLAND	6.98	0.670	11.072	1.534	AD	74.83	4.14	3.22	3.68	0	0
SIDE-410-R-2001		SIDELING HILL CR	WASHINGTON	4	HIGHLAND	6.70	0.641	11.201	1.390	AD	75.04	3.86	4.33	4.10	0	0
UMON-101-C-2001		LITTLE FISHING CR	FREDERICK	1	HIGHLAND	6.67	0.256	1.733	0.637	AD	99.49	4.43	4.56	4.49	1	0
YOUG-106-R-2001		UT LITTLE BEAR CR	GARRETT	1	HIGHLAND	7.35	0.723	11.026	0.637	none	89.29	4.14	3.67	3.90	1	0
YOUG-107-R-2001		UT YOUGHIOGHENY R	GARRETT	1	HIGHLAND	6.97	0.830	7.224	0.560	AD	77.59		3.89	3.89	0	0
YOUG-117-R-2001		MILL RUN	GARRETT	1	HIGHLAND	6.95	1.360	6.580	0.791	AD	75.75	4.43	4.33	4.38	1	0
YOUG-123-R-2001		UT MILL RUN	GARRETT	1	HIGHLAND	6.07	0.912	13.312	0.942	AD	84.75	3.57	4.78	4.17	1	0
YOUG-127-R-2001		UT LITTLE BEAR CR	GARRETT	1	HIGHLAND	7.28	0.676	11.129	0.710	AD	91.46	3.86	3.89	3.87	1	0
YOUG-208-R-2001		BEAR BR	GARRETT	2	HIGHLAND	6.90	1.477	9.066	1.646	AD	57.71	3.57	4.78	4.17	1	0
YOUG-214-R-2001		YOUGHIOGHENY R	GARRETT	2	HIGHLAND	7.13	0.927	6.716	1.088	AD	70.20	3.29	4.11	3.70	0	0
YOUG-219-R-2001		YOUGHIOGHENY R	GARRETT	2	HIGHLAND	7.00	1.032	6.697	1.010	AD	66.34	3.00	3.89	3.44	0	0
YOUG-320-R-2001		MUDDY CR	GARRETT	3	HIGHLAND	6.69	0.359	6.995	1.644	AD	74.17	3.00	4.78	3.89	0	0

Table Appendix D5

SITE	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
CORS-102-S-2001	2001	KIRBY CREEK	1	COASTAL-E	6.56	0.440	8.241	8.682	ORG & AD	89.92	1.75	2.71	2.71	0	1
LOCR-102-S-2001	2001	SWAN CREEK	1	COASTAL-E	5.92	0.169	7.821	20.150	ORG	85.19	2.75	1.86	1.86	0	1
NASS-108-S-2001	2001	MILLVILLE CREEK	1	COASTAL-E	4.36	0.182	5.479	27.625	ORG	77.82	2.25	1.29	1.29	0	1
NASS-302-S-2001	2001	NASSAWANGO CREEK	3	COASTAL-E	6.25	0.252	7.297	12.198	ORG & AD	71.66		3.29	3.29	0	1
UPCK-113-S-2001	2001	SKELETON CREEK	1	COASTAL-E	6.12	0.303	10.977	17.414	ORG & AD	61.00	2.50	2.71	2.71	0	1
WIRH-220-S-2001	2001	LEONARD POND RUN	2	COASTAL-E	6.76	3.860	5.137	3.652	NONE	51.41	3.25	4.43	3.84	0	0
MATT-033-S-2001	2001	MATTAWOMAN CREEK	3	COASTAL-W	6.72	0.115	11.134	3.497	AD	69.69	3.00	3.29	3.14	0	0
NANJ-331-S-2001	2001	MILL RUN	3	COASTAL-W	6.66	0.236	10.836	1.649	AD	81.36	2.50	4.71	3.61	0	0
PAXL-294-S-2001	2001	SWANSON CREEK	2	COASTAL-W	6.94	0.424	14.800	1.864	AD	69.82	3.00	4.14	3.57	0	0
PTOB-002-S-2001	2001	HOGHOLE RUN	2	COASTAL-W	6.59	0.001	9.788	1.523	AD	82.68	4.25	3.86	4.05	0	0
STCL-051-S-2001	2001	UT ST CLEMENTS CREEK	1	COASTAL-W	6.96	0.001	6.558	2.560	NONE	74.93		4.71	4.71	0	0
WCHE-086-S-2001	2001	PLUM POINT CREEK	2	COASTAL-W	7.35	0.229	16.837	2.851	NONE	73.87	1.75	3.00	2.38	0	0
ZEKI-012-S-2001	2001	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.66	0.214	7.363	1.740	AD	93.04	3.50	4.14	3.82	0	0
FURN-101-S-2001	2001	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.78	0.622	4.882	3.074	AD	86.46	3.89	4.11	4.00	0	0
JONE-109-S-2001	2001	DIPPING POND RUN	1	EPIEDMNT	6.67	2.921	1.138	1.091	NONE	76.78		4.11	4.11	0	0
JONE-315-S-2001	2001	NORTH BR JONES FALLS	3	EPIEDMNT	8.20	1.522	4.298	1.134	NONE	55.31	3.44	3.00	3.22	0	0
LIBE-102-S-2001	2001	TIMBER RUN	1	EPIEDMNT	7.14	1.272	4.273	1.140	NONE	74.67	3.22	3.44	3.33	1	0
LOCH-120-S-2001	2001	BAISMANS RUN	1	EPIEDMNT	7.14	1.658	2.888	0.790	AD	59.81	2.56	4.33	4.33	1	0
RKGR-119-S-2001	2001	UN TRIB TO PATUXENT R	1	EPIEDMNT	6.81	1.648	5.922	1.077	NONE	65.20	3.44	4.11	3.78	0	0
FIMI-207-S-2001	2001	FIFTEENMILE CREEK	3	HIGHLAND	7.10	0.402	8.793	0.898	AD	89.51	3.57	3.44	3.51	0	0
PRLN-626-S-2001	2001	MILL RUN	2	HIGHLAND	7.67	0.841	12.188	0.879	NONE	100.00	3.86	4.11	3.98	1	0
SAVA-204-C-2001	2001	CRABTREE CR	2	HIGHLAND	7.37	0.707	12.914	0.579	NONE	89.30	3.86	4.33	4.10	1	0
SAVA-225-S-2001	2001	SAVAGE RIVER	3	HIGHLAND	7.22	0.917	10.399	1.173	AD	83.84	4.14	3.67	3.90	1	0
SAVA-276-S-2001	2001	DOUBLE LICK RUN	1	HIGHLAND	6.76	0.542	10.703	0.284	AD	91.01	4.14	3.89	4.02	1	0
UMON-119-S-2002		BUZZARD BRANCH	1	HIGHLAND											
UMON-288-S-2001	2001	TRIB TO HUNTING CREEK	1	HIGHLAND	6.52	0.396	3.656	0.678	AD	87.89	2.43	4.33	4.33	1	0
YOUG-432-S-2001	2001	BEAR CREEK	3	HIGHLAND	6.47	1.023	8.589	0.956	AD	76.35	4.14	4.56	4.35	1	0

Table Appendix D6

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
LOCR-102-S-2002	SENTINEL	SWAN CREEK	KENT	1	COASTAL-E	5.82	0.072	24.622	15.856	ORG & AD	85.19	2.50	1.86	1.86	0	1
NASS-108-S-2002	SENTINEL	MILLVILLE CREEK	WORCESTER	1	COASTAL-E	4.40	0.032	11.121	18.625	ORG & AD	77.82		1.00	1.00	0	1
NASS-302-S-2002	SENTINEL	NASSAWANGO CREEK	WORCESTER	3	COASTAL-E	6.52	0.001	8.622	10.680	none	71.66	4.25	3.57	3.91	0	0
LOCR-110-R-2002		GRAYS INN CR UT	KENT	1	COASTAL-E	5.80	0.136	30.732	22.013	ORG & AD	56.93		2.43	2.43	0	1
NANJ-331-S-2002	SENTINEL	MILL RUN	CHARLES	3	COASTAL-W	6.60	0.090	9.923	3.144	AD	81.36	4.25	4.71	4.48	0	0
PAXL-294-S-2002	SENTINEL	SWANSON CREEK	CHARLES	2	COASTAL-W	6.83	0.213	15.373	3.770	none	69.82	4.50	4.14	4.32	0	0
PTOB-002-S-2002	SENTINEL	HOGHOLE RUN	CHARLES	2	COASTAL-W	6.62	0.036	7.705	3.662	AD	82.68	4.25	4.71	4.48	0	0
STCL-051-S-2002	SENTINEL	ST CLEMENTS CR UT1	ST. MARY'S	1	COASTAL-W	7.06	0.001	5.584	3.437	none	74.93		4.71	4.71	0	0
WCHE-086-S-2002	SENTINEL	PLUM POINT CREEK	CALVERT	2	COASTAL-W	7.14	0.116	16.182	5.006	none	73.87		3.57	3.57	0	0
ZEKI-012-S-2002	SENTINEL	ZEKIAH SWAMP RUN UT3	CHARLES	1	COASTAL-W	6.81	0.096	8.735	4.136	none	93.04	4.50	4.14	4.32	0	0
BRET-408-R-2002		MACINTOSH RUN	ST. MARY'S	4	COASTAL-W	7.33	0.200	8.195	4.441	none	72.72	2.50	4.71	3.61	0	0
PRMT-118-R-2002		REEDER RUN UT	CHARLES	1	COASTAL-W	6.64	0.055	4.304	4.163	AD	92.16	4.50	3.00	3.75	0	0
PRMT-206-R-2002		REEDER RUN	CHARLES	2	COASTAL-W	6.81	0.128	6.849	4.072	none	91.96	4.50	3.29	3.89	0	0
PRMT-315-R-2002		REEDER RUN	CHARLES	3	COASTAL-W	7.17	0.085	7.946	5.702	none	90.51	4.25	4.14	4.20	0	0
SOUT-108-R-2002		TARNANS BR	ANNE ARUNDEL	1	COASTAL-W	6.10	0.127	12.450	1.536	AD	53.82	5.00	2.43	3.71	0	0
STCL-110-R-2002		ST CLEMENTS CR UT 1	ST. MARY'S	1	COASTAL-W	7.08	0.160	6.137	4.335	none	60.19	4.00	4.14	4.07	0	0
STCL-112-R-2002		TOMAKOKIN CR UT	ST. MARY'S	1	COASTAL-W	6.31	0.374	2.142	4.752	AD	87.56		4.71	4.71	0	0
FURN-101-S-2002	SENTINEL	PRINCIPIO CR UT2	CECIL	1	EPIEDMNT	6.91	0.656	4.620	2.494	AD	86.46	4.11	4.33	4.22	0	0
JONE-109-S-2002	SENTINEL	DIPPING POND RUN UT1	BALTIMORE	1	EPIEDMNT	6.41	3.169	1.246	0.946	none	76.78		3.89	3.89	0	0
JONE-315-S-2002	SENTINEL	NORTH BR JONES FALLS	BALTIMORE	3	EPIEDMNT	8.05	0.960	5.600	1.775	none	55.31	3.44	3.44	3.44	0	0
LIBE-102-S-2002	SENTINEL	TIMBER RUN	BALTIMORE	1	EPIEDMNT	7.01	1.210	4.272	1.210	none	74.67	3.22	4.33	3.78	1	0
LOCH-120-S-2002	SENTINEL	BAISMAN RUN	BALTIMORE	1	EPIEDMNT	7.32	1.594	2.204	1.129	none	59.81		3.67	3.67	1	0
RKGR-119-S-2002	SENTINEL	PATUXENT R UT4	HOWARD	1	EPIEDMNT	7.88	1.599	5.783	1.403	none	65.20	3.22	3.67	3.44	0	0
JONE-101-R-2002		NORTH BR UT 1_UT1	BALTIMORE	1	EPIEDMNT	7.90	2.095	5.162	1.151	none	53.12	2.78	3.89	3.33	0	0
JONE-107-R-2002		NORTH BR	BALTIMORE	1	EPIEDMNT	7.04	0.604	4.942	2.709	none	78.39		4.11	4.11	0	0
JONE-204-R-2002		NORTH BR UT 1	BALTIMORE	2	EPIEDMNT	7.80	2.050	5.063	1.059	none	55.12	2.56	3.89	3.22	0	0
JONE-213-R-2002		JONES FALLS	BALTIMORE	2	EPIEDMNT	7.83	2.045	6.483	1.501	none	59.97	2.56	3.67	3.11	0	0
JONE-303-R-2002		JONES FALLS	BALTIMORE	3	EPIEDMNT	8.05	1.672	12.732	1.752	none	52.77	3.00	3.44	3.22	0	0
LOCH-216-R-2002		OWL BRANCH UT	BALTIMORE	2	EPIEDMNT	7.23	1.766	3.890	1.141	none	60.66		4.56	4.56	1	0
LOGU-202-R-2002		COWEN RUN	BALTIMORE	2	EPIEDMNT	8.07	1.882	12.599	1.811	none	60.46	4.33	3.67	4.00	0	0
RKGR-101-R-2002		ROCKY GORGE RES UT 2	HOWARD	1	EPIEDMNT	7.46	1.579	5.413	2.424	none	52.74	3.22	4.33	3.78	0	0
FIMI-207-S-2002	SENTINEL	FIFTEENMILE CR	ALLEGANY	3	HIGHLAND	7.28	0.256	11.778	1.494	none	89.51	3.86	3.22	3.54	0	0
PRLN-626-S-2002	SENTINEL	MILL RUN (NO)	ALLEGANY	2	HIGHLAND	7.16	1.888	13.214	1.618	none	100.00		4.56	4.56	1	0
SAVA-204-S-2002	SENTINEL	CRABTREE CR	GARRETT	2	HIGHLAND	6.93	0.791	14.104	0.886	AD	89.30		3.67	3.67	1	0
SAVA-225-S-2002	SENTINEL	SAVAGE R	GARRETT	3	HIGHLAND	7.21	0.871	12.284	2.572	AD	83.84		4.33	4.33	1	0
SAVA-276-S-2002	SENTINEL	DOUBLE LICK RUN	GARRETT	1	HIGHLAND	6.46	0.570	11.630	0.547	AD	91.01	3.29	4.56	3.92	1	0
UMON-119-S-2002	SENTINEL	BUZZARD BRANCH	FREDERICK	1	HIGHLAND	7.46	0.189	8.352	2.740	none	99.33		4.56	4.56	1	0
UMON-288-S-2002	SENTINEL	HIGH RUN	FREDERICK	1	HIGHLAND	6.87	0.227	3.190	1.156	AD	87.89	2.43	4.33	3.38	0	0
YOUG-432-S-2002	SENTINEL	BEAR CR	GARRETT	3	HIGHLAND	7.11	1.234	9.605	1.439	AD	76.35	4.14	3.89	4.02	1	0
DOUB-116-R-2002		BIG PIPE CR UT 5	CARROLL	1	HIGHLAND	7.20	1.382	6.477	1.013	none	52.85	2.43	4.56	3.49	0	0
DOUB-407-R-2002		BIG PIPE CREEK	CARROLL	4	HIGHLAND	8.21	3.459	10.063	2.318	none	57.88	2.43	3.89	3.16	0	0
PRMO-112-R-2002		GREEN BRIAR BRANCH	MONTGOMERY	1	HIGHLAND	7.81	0.652	19.127	4.699	none	70.49	3.29	3.89	3.59	0	0
PRMO-114-R-2002		LITTLE MONOCACY R UT 2	MONTGOMERY	1	HIGHLAND	6.72	0.687	6.017	1.601	none	82.65	2.43	3.67	3.05	0	0
PRMO-115-R-2002		LITTLE MONOCACY R UT 2	MONTGOMERY	1	HIGHLAND	6.91	0.695	5.894	1.563	none	76.32	2.71	4.33	3.52	0	0
PRWA-101-R-2002		GREEN SPRING RUN	WASHINGTON	1	HIGHLAND	6.95	0.536	23.920	3.003	none	95.27		3.67	3.67	0	0
PRWA-114-R-2002		POTOMAC R UT 1	WASHINGTON	1	HIGHLAND	7.00	0.203	8.350	2.064	none	66.21		3.44	3.44	0	0
PRWA-206-R-2002		GREEN SPRING RUN	WASHINGTON	2	HIGHLAND	8.11	0.606	18.001	1.581	none	91.14	3.57	2.78	3.17	0	0
SAVA-105-R-2002		BIG RUN WHISKEY HOLLOW UT	GARRETT	1	HIGHLAND	6.87	0.604	8.682	0.711	AD	98.46		4.56	4.56	1	0
SAVA-117-R-2002		BEAR PEN RUN	GARRETT	1	HIGHLAND	6.55	0.600	13.120	0.922	AD	72.86		4.33	4.33	1	0
SAVA-119-R-2002		DRY RUN	GARRETT	1	HIGHLAND	7.18	1.169	13.129	1.067	AD	79.81		4.11	4.11	1	0
SAVA-120-R-2002		TOM'S SPRING RUN	GARRETT	1	HIGHLAND	7.02	0.792	13.169	0.795	none	91.55	3.00	4.33	3.67	1	0
SAVA-206-R-2002		MUDLICK RUN	GARRETT	2	HIGHLAND	7.14	1.278	9.586	1.552	AD	55.37	3.00	4.33	3.67	1	0
SAVA-308-R-2002		SAVAGE RIVER	GARRETT	3	HIGHLAND	7.26	0.749	11.632	1.424	AD	83.00	3.86	4.56	4.21	1	0

Table Appendix D6

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
SAVA-312-R-2002		MIDDLE FORK RUN	GARRETT	3	HIGHLAND	7.02	0.919	13.399	1.299	AD	88.59	3.57	4.56	4.06	1	0
SAVA-401-R-2002		SAVAGE RIVER	GARRETT	4	HIGHLAND	7.39	0.880	13.051	1.523	none	63.33		3.89	3.89	1	0
SAVA-410-R-2002		SAVAGE RIVER	GARRETT	4	HIGHLAND	7.35	0.869	12.744	1.558	none	87.10		3.89	3.89	1	0
SAVA-414-R-2002		SAVAGE RIVER	GARRETT	4	HIGHLAND	7.38	0.870	13.124	1.463	none	87.25		3.44	3.44	1	0
TOWN-205-R-2002		MURLEY BRANCH	ALLEGANY	2	HIGHLAND	7.84	1.635	26.014	2.053	none	61.28	2.14	3.89	3.02	0	0
TOWN-417-R-2002		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.51	0.532	17.396	2.987	none	84.27	3.86	4.11	3.98	0	0
TOWN-419-R-2002		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.67	0.202	13.711	2.194	none	83.40	3.86	4.11	3.98	0	0
TOWN-420-R-2002		TOWN CREEK	ALLEGANY	4	HIGHLAND	7.91	0.194	13.318	2.148	none	83.56	3.86	4.11	3.98	0	0

Table Appendix D7

SITE	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
LOCR-102-S-2002	2002	SWAN CREEK	1	COASTAL-E	5.82	0.072	24.622	15.856	ORG & AD	85.19	2.50	1.86	1.86	0	1
NASS-108-S-2002	2002	MILLVILLE CREEK	1	COASTAL-E	4.40	0.032	11.121	18.625	ORG & AD	77.82		1.00	1.00	0	1
NASS-302-S-2002	2002	NASSAWANGO CREEK	3	COASTAL-E	6.52	0.001	8.622	10.680	none	71.66	4.25	3.57	3.91	0	0
CORS-102-S-2002	2002	EMORY CR UT1	1	COASTAL-E	6.80	0.233	27.510	6.518	none	89.92	DRY	1.57	1.57	0	0
UPCK-113-S-2002	2002	UT CHOPTANK RIVER	1	COASTAL-E	6.84	0.361	24.108	3.536	none	61.00	2.75	2.43	2.59	0	0
WIRH-220-S-2002	2002	LEONARD MILL RUN	2	COASTAL-E	6.87	6.185	6.621	1.958	none	51.41	3.50	3.86	3.68	0	0
MATT-033-S-2002	2002	MATTAWOMAN CREEK	3	COASTAL-W	6.58	0.122	14.337	6.011	AD	69.69	2.50	3.00	2.75	0	0
NANJ-331-S-2002	2002	MILL RUN	3	COASTAL-W	6.60	0.090	9.923	3.144	AD	81.36	4.25	4.71	4.48	0	0
PAXL-294-S-2002	2002	SWANSON CREEK	2	COASTAL-W	6.83	0.213	15.373	3.770	none	69.82	4.50	4.14	4.32	0	0
PTOB-002-S-2002	2002	HOGHOLE RUN	2	COASTAL-W	6.62	0.036	7.705	3.662	AD	82.68	4.25	4.71	4.48	0	0
STCL-051-S-2002	2002	ST CLEMENTS CR UT1	1	COASTAL-W	7.06	0.001	5.584	3.437	none	74.93		4.71	4.71	0	0
ZEKI-012-S-2002	2002	ZEKIAH SWAMP RUN UT3	1	COASTAL-W	6.81	0.096	8.735	4.136	none	93.04	4.50	4.14	4.32	0	0
FURN-101-S-2002	2002	PRINCIPIO CR UT2	1	EPIEDMNT	6.91	0.656	4.620	2.494	AD	86.46	4.11	4.33	4.22	0	0
JONE-109-S-2002	2002	DIPPING POND RUN UT1	1	EPIEDMNT	6.41	3.169	1.246	0.946	none	76.78		3.89	3.89	0	0
JONE-315-S-2002	2002	NORTH BR JONES FALLS	3	EPIEDMNT	8.05	0.960	5.600	1.775	none	55.31	3.44	3.44	3.44	0	0
LIBE-102-S-2002	2002	TIMBER RUN	1	EPIEDMNT	7.01	1.210	4.272	1.210	none	74.67	3.22	4.33	3.78	1	0
LOCH-120-S-2002	2002	BAISMAN RUN	1	EPIEDMNT	7.32	1.594	2.204	1.129	none	59.81		3.67	3.67	1	0
RKGR-119-S-2002	2002	PATUXENT R UT4	1	EPIEDMNT	7.88	1.599	5.783	1.403	none	65.20	3.22	3.67	3.44	0	0
FIMI-207-S-2002	2002	FIFTEENMILE CR	3	HIGHLAND	7.28	0.256	11.778	1.494	none	89.51	3.86	3.22	3.54	0	0
PRLN-626-S-2002	2002	MILL RUN (NO)	2	HIGHLAND	7.16	1.888	13.214	1.618	none	100.00		4.56	4.56	1	0
SAVA-204-S-2002	2002	CRABTREE CR	2	HIGHLAND	6.93	0.791	14.104	0.886	AD	89.30		3.67	3.67	1	0
SAVA-225-S-2002	2002	SAVAGE R	3	HIGHLAND	7.21	0.871	12.284	2.572	AD	83.84		4.33	4.33	1	0
SAVA-276-S-2002	2002	DOUBLE LICK RUN	1	HIGHLAND	6.46	0.570	11.630	0.547	AD	91.01	3.29	4.56	3.92	1	0
UMON-119-S-2002	2002	BUZZARD BRANCH	1	HIGHLAND	7.46	0.189	8.352	2.740	none	99.33		4.56	4.56	1	0
UMON-288-S-2002	2002	HIGH RUN	1	HIGHLAND	6.87	0.227	3.190	1.156	AD	87.89	2.43	4.33	3.38	0	0
YOUG-432-S-2002	2002	BEAR CR	3	HIGHLAND	7.11	1.234	9.605	1.439	AD	76.35	4.14	3.89	4.02	1	0

Table Appendix D8

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
CORS-102-S-2003	SENTINEL	EMORY CR UT1	QA	1	COASTAL-E	6.44	0.166	8.797	14.167	ORG & AD	89.92	2.2500	2.1400	2.1400	0	1
LOCR-102-S-2003	SENTINEL	SWAN CR	KE	1	COASTAL-E	5.79	0.029	7.845	24.922	ORG	85.19	3.2500	1.5700	2.4100	0	1
NASS-108-S-2003	SENTINEL	MILLVILLE CR	WO	1	COASTAL-E	4.40	0.004	5.100	29.902	ORG	77.82	2.5000	1.8600	1.8600	0	1
NASS-302-S-2003	SENTINEL	NASSAWANGO CR	WO	3	COASTAL-E	5.87	0.174	5.123	19.267	ORG	71.66	3.7500	3.8600	3.8000	0	1
UPCK-113-S-2003	SENTINEL	UT CHOPTANK RIVER	CN	1	COASTAL-E	6.10	0.109	10.966	21.174	ORG & AD	61.00	3.2500	2.4300	2.8400	0	1
WIRH-220-S-2003	SENTINEL	LEONARD MILL RUN	WI	2	COASTAL-E	6.50	2.453	6.238	6.096	none	51.41	3.5000	3.0000	3.2500	0	0
LICK-127-R-2003		UT CORSEY CREEK	DO	1	COASTAL-E	4.46	0.000	12.808	29.373	ORG & AD	89.73		1.2900	1.2900	0	1
MANO-105-R-2003		HALL BR	SO	1	COASTAL-E	5.45	0.139	19.510	16.222	ORG & AD	55.92		1.8600	1.8600	0	1
MANO-107-R-2003		KINGS CR (PC)	SO	1	COASTAL-E	4.40	0.448	13.597	14.933	ORG & AD	85.88		1.5700	1.5700	0	1
MANO-108-R-2003		GEANQUAKIN CR	SO	1	COASTAL-E	4.50	0.000	12.021	47.857	ORG	75.48		1.0000	1.0000	0	1
MANO-111-R-2003		MOORE BR	SO	1	COASTAL-E	4.07	0.129	17.193	24.217	ORG & AD	90.99		1.5700	1.5700	0	1
MANO-113-R-2003		LORETTO BR UT1	SO	1	COASTAL-E	5.05	0.009	14.297	15.133	ORG & AD	86.29	3.5000	1.5700	2.5400	0	1
MANO-117-R-2003		MOORE BR	SO	1	COASTAL-E	5.74	0.553	9.828	21.783	ORG & AD	84.73		1.0000	1.0000	0	1
PCSO-102-R-2003		MARUMSCO CR	SO	1	COASTAL-E	5.50	0.281	28.347	13.184	ORG & AD	58.17		1.5700	1.5700	0	1
PCSO-118-R-2003		MARUMSCO CR	SO	1	COASTAL-E	5.46	0.281	26.887	13.011	ORG & AD	57.27		1.5700	1.5700	0	1
UELK-215-R-2003		MILL CR (ELK)	CE	2	COASTAL-E	6.41	0.330	12.742	5.026	AD	81.26	3.5000	4.1400	3.8200	0	0
PAXL-294-S-2003	SENTINEL	SWANSON CR	CH	2	COASTAL-W	6.46	0.536	17.537	2.947	AD	69.71	2.5000	3.8600	3.1800	0	0
MATT-033-S-2003	SENTINEL	MATTAWOMAN CR	CH	3	COASTAL-W	6.46	0.247	16.205	3.659	AD	70.03	3.5000	2.7100	3.1100	0	0
NANJ-331-S-2003	SENTINEL	MILL RUN	CH	3	COASTAL-W	6.14	0.388	14.909	1.999	AD	81.25	3.0000	3.0000	3.0000	0	0
PTOB-113-R-2003		PORT TOBACCO R UT2	CH	1	COASTAL-W	6.37	0.341	13.845	3.226	AD	87.11	3.0000	4.4300	3.7100	0	0
SEVE-101-R-2003		JABEZ BR	AA	1	COASTAL-W	6.37	0.885	8.207	4.117	AD	61.79		4.1400	4.1400	1	0
SEVE-112-R-2003		SEVERN RUN UT1	AA	1	COASTAL-W	5.21	0.335	38.034	9.035	ORG & AD	50.25		1.5700	1.5700	0	1
SEVE-203-R-2003		JABEZ BR	AA	2	COASTAL-W	6.66	0.926	11.946	3.904	AD	56.87	3.0000	4.7100	3.8600	0	0
SEVE-210-R-2003		JABEZ BR	AA	2	COASTAL-W	6.50	0.904	11.850	4.198	AD	61.05	2.2500	4.7100	3.4800	0	0
STMA-107-R-2003		MARTIN COVE UT1	SM	1	COASTAL-W	6.90	1.018	12.961	3.555	none	59.51		3.0000	3.0000	0	0
STMA-119-R-2003		BROOM CR	SM	1	COASTAL-W	6.35	0.928	11.458	2.657	AD	67.32		3.0000	3.0000	0	0
STMA-208-R-2003		JOHNS CR	SM	2	COASTAL-W	6.18	1.246	12.901	4.222	AD	61.60	4.2500	4.1400	4.2000	0	0
STMA-218-R-2003		JARBOESVILLE RUN	SM	2	COASTAL-W	6.02	0.119	6.710	3.371	AD	60.08	4.5000	2.1400	3.3200	0	0
WCHE-104-R-2003		PARKER CR UT1	CA	1	COASTAL-W	7.05	0.251	10.687	4.190	none	70.81		3.5700	3.5700	0	0
WCHE-106-R-2003		PARKER CR UT3	CA	1	COASTAL-W	7.17	0.005	27.351	2.728	none	95.37		3.0000	3.0000	0	0
FURN-101-S-2003	SENTINEL	PRINCIPIO CR UT2	CE	1	EPIEDMNT	6.65	0.516	5.612	3.261	AD	86.46	3.0000	3.4400	3.2200	0	0
JONE-109-S-2003	SENTINEL	DIPPING POND RUN	BA	1	EPIEDMNT	6.34	2.649	3.818	1.002	none	76.78		4.1100	4.1100	0	0
LIBE-102-S-2003	SENTINEL	TIMBER RUN	BA	1	EPIEDMNT	6.55	1.265	6.241	2.389	AD	74.67	2.7800	3.6700	3.6700	1	0
LOCH-120-S-2003	SENTINEL	BAISMAN RUN	BA	1	EPIEDMNT	7.01	1.655	6.464	1.024	AD	62.99	2.5600	2.5600	2.5600	1	0
RKGR-119-S-2003	SENTINEL	UT PATUXENT RIVER	HA	1	EPIEDMNT	7.56	1.456	7.678	1.344	none	65.20	3.0000	3.4400	3.2200	0	0
LIBE-129-R-2003		TIMBER RUN	BA	1	EPIEDMNT	6.82	1.367	6.412	2.762	AD	66.96		3.4400	3.4400	1	0
FIMI-207-S-2003	SENTINEL	FIFTENMILE CR	AL	3	HIGHLAND	7.14	0.301	9.512	1.197	AD	89.69	4.4300	3.8900	4.1600	0	0
PRLN-626-S-2003	SENTINEL	MILL RUN (NO)	AL	2	HIGHLAND	7.59	1.141	13.293	1.078	none	100.00	2.4300	4.3300	4.3300	1	0
SAVA-204-S-2003	SENTINEL	CRABTREE CREEK	GA	2	HIGHLAND	7.66	0.519	14.270	0.711	none	89.30	3.2900	4.1100	3.7000	1	0
SAVA-225-S-2003	SENTINEL	SAVAGE RIVER	GA	3	HIGHLAND	7.11	0.995	11.522	1.901	AD	83.84	3.0000	4.7800	3.8900	1	0
SAVA-276-S-2003	SENTINEL	DOUBLE LICK RUN	GA	1	HIGHLAND	6.70	0.557	11.309	0.352	AD	91.01	3.2900	4.1100	3.7000	1	0
UMON-119-S-2003	SENTINEL	BUZZARD BRANCH	FR	1	HIGHLAND	7.25	0.387	7.125	2.318	none	99.33	2.1400	4.7800	4.7800	1	0
UMON-288-S-2003	SENTINEL	UT HUNTING CREEK	FR	1	HIGHLAND	6.54	0.321	4.622	1.378	AD	87.89	2.4300	5.0000	5.0000	1	0
YOUG-432-S-2003	SENTINEL	BEAR CR	GA	3	HIGHLAND	7.10	0.738	8.373	0.799	AD	76.35	3.8600	3.6700	3.7600	1	0
COCA-112-N-2003		UT POTOMAC RIVER	AL	1	HIGHLAND	6.88	0.160	16.873	1.583	ORG	98.52	3.0000	3.8900	3.4400	0	0
COCA-116-N-2003		UT POTOMAC RIVER	AL	1	HIGHLAND	7.27	0.073	15.122	1.737	none	99.66		3.2200	3.2200	0	0
COCA-211-N-2003		UT POTOMAC RIVER	AL	2	HIGHLAND	7.14	0.094	14.101	1.773	ORG	99.24		3.2200	3.2200	0	0
COCA-302-N-2003		SEVEN SPRINGS RUN	AL	3	HIGHLAND	8.09	0.085	24.756	2.535	none	86.57	3.8600	3.2200	3.5400	0	0
COCA-303-N-2003		SEVEN SPRINGS RUN	AL	3	HIGHLAND	7.61	0.074	25.210	2.492	none	87.18	3.8600	3.6700	3.7600	0	0
ANTI-113-R-2003		LITTLE ANTIETAM CR	WA	1	HIGHLAND	7.59	2.638	13.741	1.245	none	73.73		3.4400	3.4400	1	0
ANTI-208-R-2003		SHARMANS BR	WA	2	HIGHLAND	7.74	0.826	11.903	2.531	none	75.65	3.2900	3.8900	3.5900	0	0
ANTI-215-R-2003		ANTIETAM CREEK UT	WA	2	HIGHLAND	8.17	0.671	11.799	1.399	none	80.49	2.1400	3.8900	3.0100	0	0
CATO-104-R-2003		MIDDLE CR (CATOCTIN)	FR	1	HIGHLAND	6.51	0.179	9.216	1.371	AD	99.10		4.5600	4.5600	0	0
CATO-109-R-2003		CATOCTIN CR UT3	FR	1	HIGHLAND	7.25	1.296	17.891	0.759	none	77.46		3.6700	3.6700	0	0
CATO-212-R-2003		GRINDSTONE RUN	FR	2	HIGHLAND	7.57	1.593	16.988	1.423	none	59.94	2.4300	4.3300	3.3800	0	0
CATO-301-R-2003		CATOCTIN CR	FR	3	HIGHLAND	8.42	0.894	13.154	2.027	none	61.17	3.8600	3.8900	3.8700	0	0
GEOR-107-R-2003		ELK LICK RUN	AL	1	HIGHLAND	6.95	0.494	10.823	0.821	AD	88.01		4.1100	4.1100	1	0
GEOR-114-R-2003		STAUB RUN	AL	1	HIGHLAND	6.89	0.596	6.389	0.210	AD	97.07		4.1100	4.1100	1	0
GEOR-211-R-2003		ELK LICK RUN	AL	2	HIGHLAND	7.42	0.491	10.274	0.322	none	93.53	1.8600	4.7800	3.3200	0	0
LMON-109-R-2003		TALBOT BR UT1	FR	1	HIGHLAND	7.19	1.635	5.712	0.990	none	60.72	2.7100	3.6700	3.1900	0	0

Table Appendix D8

SITE	SITE TYPE	STREAM NAME	COUNTY	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
LMON-123-R-2003		TOWN BR UT1	FR	1	HIGHLAND	6.79	2.231	6.909	3.883	none	54.22		3.2200	3.2200	0	0
LMON-131-R-2003		BENNETT CR	MO	1	HIGHLAND	7.34	2.431	8.943	0.871	none	57.61	2.7100	3.4400	3.0800	0	0
LMON-210-R-2003		FURNACE BR	FR	2	HIGHLAND	7.49	2.068	7.876	1.842	none	65.69	3.8600	2.5600	3.2100	0	0
PRLN-119-R-2003		POTOMAC R UT2 UT1	AL	1	HIGHLAND	6.80	1.266	13.102	0.843	AD	100.00		3.2200	3.2200	0	0
PRLN-122-R-2003		MILL RUN (NO) UT2 UT1	AL	1	HIGHLAND	6.75	1.017	12.151	0.447	AD	100.00		4.1100	4.1100	0	0
PRLN-306-R-2003		COLLIER RUN	AL	3	HIGHLAND	7.35	0.364	14.487	1.853	none	88.97	2.7100	4.3300	3.5200	0	0
PRLN-316-R-2003		COLLIER RUN	AL	3	HIGHLAND	7.11	0.368	14.617	1.850	none	89.13	2.7100	4.3300	3.5200	0	0
PRLN-318-R-2003		COLLIER RUN	AL	3	HIGHLAND	7.23	0.291	14.599	1.882	none	89.11	2.4300	4.5600	3.4900	0	0

Table Appendix D9

SITE (95-97)	SITENEW	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
KE-N-096-102-95	LOCR-102-S-1995	1995	SWAN CREEK	1	COASTAL-E	5.86	0.120	17.460	20.000	ORG & AD	70.33	2.75	1.86	1.86	0	1
	LOCR-102-S-2000	2000	SWAN CREEK	1	COASTAL-E	6.02	0.085	4.943	33.182	ORG	85.19	2.75	1.29	1.29	0	1
	LOCR-102-S-2001	2001	SWAN CREEK	1	COASTAL-E	5.92	0.169	7.821	20.150	ORG	85.19	2.75	1.86	1.86	0	1
	LOCR-102-S-2002	2002	SWAN CREEK	1	COASTAL-E	5.82	0.072	24.622	15.856	ORG & AD	85.19	2.50	1.86	1.86	0	1
	LOCR-102-S-2003	2003	SWAN CREEK	1	COASTAL-E	5.79	0.029	7.845	24.922	ORG	85.19	3.25	1.57	2.41	0	1
WO-S-038-108-97	NASS-108-S-1997	1997	MILLVILLE CREEK	1	COASTAL-E	4.40	0.350	3.990	32.900	ORG	83.23	3.25	1.29	2.27	0	1
	NASS-108-S-2000	2000	MILLVILLE CREEK	1	COASTAL-E	4.41	0.082	3.405	36.061	ORG	77.82	2.00	1.00	1.00	0	1
	NASS-108-S-2001	2001	MILLVILLE CREEK	1	COASTAL-E	4.36	0.182	5.479	27.625	ORG	77.82	2.25	1.29	1.29	0	1
	NASS-108-S-2002	2002	MILLVILLE CREEK	1	COASTAL-E	4.40	0.032	11.121	18.625	ORG & AD	77.82	2.00	1.00	1.00	0	1
	NASS-108-S-2003	2003	MILLVILLE CREEK	1	COASTAL-E	4.40	0.004	5.100	29.902	ORG	77.82	2.50	1.86	1.86	0	1
CN-N-024-113-96	UPCK-113-S-1996	1996	SKELETON CREEK	1	COASTAL-E	5.95	0.600	15.900	15.900	ORG & AD	61.01	2.75	2.14	2.14	0	1
	UPCK-113-S-2000	2000	SKELETON CREEK	1	COASTAL-E	5.53	0.117	6.413	28.632	ORG	61.01	2.50	2.71	2.71	0	1
	UPCK-113-S-2001	2001	SKELETON CREEK	1	COASTAL-E	6.12	0.303	10.977	17.414	ORG & AD	61.00	2.50	2.71	2.71	0	1
	UPCK-113-S-2002	2002	SKELETON CREEK	1	COASTAL-E	6.84	0.361	24.108	3.536	NONE	61.00	2.75	2.43	2.59	0	0
	UPCK-113-S-2003	2003	SKELETON CREEK	1	COASTAL-E	6.10	0.109	10.966	21.174	ORG & AD	61.00	3.25	2.43	2.84	0	1
WI-S-063-220-95	WIRH-220-S-1995	1995	LEONARD POND RUN	2	COASTAL-E	6.64	2.080	5.280	6.000	NONE	56.48	3.25	3.00	3.13	0	0
	WIRH-220-S-2000	2000	LEONARD POND RUN	2	COASTAL-E	6.23	0.548	1.734	16.032	ORG	51.41	3.25	3.57	3.41	0	1
	WIRH-220-S-2001	2001	LEONARD POND RUN	2	COASTAL-E	6.76	3.860	5.137	3.652	NONE	51.41	3.25	4.43	3.84	0	0
	WIRH-220-S-2002	2002	LEONARD POND RUN	2	COASTAL-E	6.87	6.185	6.621	1.958	NONE	51.41	3.50	3.86	3.68	0	0
	WIRH-220-S-2003	2003	LEONARD POND RUN	2	COASTAL-E	6.50	2.453	6.238	6.096	none	51.41	3.50	3.00	3.25	0	0
QA-N-086-118-95	WYER-118-S-1995	1995	UT WYE EAST RIVER	1	COASTAL-E	6.80	1.160	13.260	22.000	NONE	57.09	3.00	3.86	3.43	0	0
	WYER-118-S-2000	2000	UT WYE EAST RIVER	1	COASTAL-E	6.89	1.330	9.818	26.695	NONE	55.39	2.75	3.00	2.88	0	0
	CORS-102-R-2000	2000	KIRBY CREEK	1	COASTAL-E	6.35	0.164	5.435	17.384	ORG	89.92	1.75	3.29	3.29	0	1
	CORS-102-S-2001	2001	KIRBY CREEK	1	COASTAL-E	6.56	0.440	8.241	8.682	ORG & AD	89.92	1.75	2.71	2.71	0	1
	CORS-102-S-2002	2002	KIRBY CREEK	1	COASTAL-E	6.80	0.233	27.510	6.518	NONE	89.92	DRY	1.57	1.57	0	0
	CORS-102-S-2003	2003	KIRBY CREEK	1	COASTAL-E	6.44	0.166	8.797	14.167	ORG & AD	89.92	2.25	2.14	2.14	0	1
	NASS-302-S-2001	2001	NASSAWANGO CREEK	3	COASTAL-E	6.25	0.252	7.297	12.198	ORG & AD	71.66	3.25	3.29	3.27	0	1
	NASS-302-S-2002	2002	NASSAWANGO CREEK	3	COASTAL-E	6.52	0.001	8.622	10.680	NONE	71.66	4.25	3.57	3.91	0	0
	NASS-302-S-2003	2003	NASSAWANGO CREEK	3	COASTAL-E	5.87	0.174	5.123	19.267	ORG	71.66	3.75	3.86	3.80	0	1
CH-S-033-314-95	MATT-033-S-1995	1995	MATTAWOMAN CREEK	3	COASTAL-W	6.60	0.240	12.840	4.000	AD	69.63	3.50	2.71	3.11	0	0
	MATT-033-S-2000	2000	MATTAWOMAN CREEK	3	COASTAL-W	6.73	0.137	9.472	6.957	AD	70.03	3.50	3.86	3.68	0	0
	MATT-033-S-2001	2001	MATTAWOMAN CREEK	3	COASTAL-W	6.72	0.115	11.134	3.497	AD	69.69	3.00	3.29	3.14	0	0
	MATT-033-S-2002	2002	MATTAWOMAN CREEK	3	COASTAL-W	6.58	0.122	14.337	6.011	AD	69.69	2.50	3.00	2.75	0	0
	MATT-033-S-2003	2003	MATTAWOMAN CREEK	3	COASTAL-W	6.46	0.247	16.205	3.659	AD	70.03	3.50	2.71	3.11	0	0
CH-S-331-304-95	NANJ-331-S-1995	1995	MILL RUN	3	COASTAL-W	6.46	0.330	11.610	3.000	AD	81.14	4.75	3.86	4.31	0	0
	NANJ-331-S-2000	2000	MILL RUN	3	COASTAL-W	6.47	0.164	10.634	3.087	AD	81.25	3.00	3.57	3.29	0	0
	NANJ-331-S-2001	2001	MILL RUN	3	COASTAL-W	6.66	0.236	10.836	1.649	AD	81.36	2.50	4.71	3.61	0	0
	NANJ-331-S-2002	2002	MILL RUN	3	COASTAL-W	6.60	0.090	9.923	3.144	AD	81.36	4.25	4.71	4.48	0	0
	NANJ-331-S-2003	2003	MILL RUN	3	COASTAL-W	6.14	0.388	14.909	1.999	AD	81.25	3.00	3.00	3.00	0	0
CH-S-294-236-97	PAXL-294-S-1997	1997	SWANSON CREEK	2	COASTAL-W	6.85	0.600	14.760	2.500	AD	69.33	4.25	3.57	3.91	0	0
	PAXL-294-S-2000	2000	SWANSON CREEK	2	COASTAL-W	6.70	0.313	14.736	3.106	AD	69.71	3.00	3.86	3.43	0	0
	PAXL-294-S-2001	2001	SWANSON CREEK	2	COASTAL-W	6.94	0.424	14.800	1.864	AD	69.82	3.00	4.14	3.57	0	0
	PAXL-294-S-2002	2002	SWANSON CREEK	2	COASTAL-W	6.83	0.213	15.373	3.770	NONE	69.82	4.50	4.14	4.32	0	0
	PAXL-294-S-2003	2003	SWANSON CREEK	2	COASTAL-W	6.46	0.536	17.537	2.947	AD	69.71	2.50	3.86	3.18	0	0
CH-S-002-207-95	PTOB-002-S-1995	1995	HOGHOLE RUN	2	COASTAL-W	6.62	0.200	10.510	3.000	AD	83.58	4.50	3.29	3.90	0	0
	PTOB-002-S-2000	2000	HOGHOLE RUN	2	COASTAL-W	6.46	0.000	9.926	3.446	AD	83.55	4.25	3.57	3.91	0	0
	PTOB-002-S-2001	2001	HOGHOLE RUN	2	COASTAL-W	6.59	0.001	9.788	1.523	AD	82.68	4.25	3.86	4.05	0	0
	PTOB-002-S-2002	2002	HOGHOLE RUN	2	COASTAL-W	6.62	0.036	7.705	3.662	AD	82.68	4.25	4.71	4.48	0	0
	PTOB-002-S-2003	2003	HOGHOLE RUN	2	COASTAL-W	6.04	0.019	14.036	2.385	AD	82.68	1.75	3.29	2.52	0	0
SM-S-051-132-95	STCL-051-S-1995	1995	UT ST CLEMENTS CREEK	1	COASTAL-W	6.86	0.200	7.050	4.000	NONE	79.26		3.86	3.86	0	0
	STCL-051-S-2000	2000	UT ST CLEMENTS CREEK	1	COASTAL-W	7.03	0.000	6.053	3.436	NONE	74.93		3.57	3.57	0	0
	STCL-051-S-2001	2001	UT ST CLEMENTS CREEK	1	COASTAL-W	6.96	0.001	6.558	2.560	NONE	74.93		4.71	4.71	0	0
	STCL-051-S-2002	2002	UT ST CLEMENTS CREEK	1	COASTAL-W	7.06	0.001	5.584	3.437	NONE	74.93		4.71	4.71	0	0
	STCL-051-S-2003	2003	UT ST. CLEMENTS CREEK	1	COASTAL-W	6.77	0.021	8.783	2.942	NONE	74.93		2.71	2.71	0	0
CA-S-086-209-97	WCHE-086-S-1997	1997	PLUM POINT CREEK	2	COASTAL-W	7.36	0.000	16.210	3.200	NONE	74.93	2.75	3.29	3.02	0	0
	WCHE-086-S-2000	2000	PLUM POINT CREEK	2	COASTAL-W	7.07	0.061	14.256	5.199	NONE	74.61	2.00	2.14	2.07	0	0
	WCHE-086-S-2001	2001	PLUM POINT CREEK	2	COASTAL-W	7.35	0.229	16.837	2.851	NONE	73.87	1.75	3.00	2.38	0	0
	WCHE-086-S-2002	2002	PLUM POINT CREEK	2	COASTAL-W	7.14	0.116	16.182	5.006	NONE	73.87	DRY	3.57	3.57	0	0

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SITE (95-97)	SITENEW	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
CH-S-012-114-95	ZEKI-012-S-1995	1995	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.20	0.340	14.820	3.000	AD	95.19	3.75	4.43	4.09	0	0
	ZEKI-012-S-2000	2000	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.52	0.079	7.876	2.566	AD	92.95	3.25	4.14	3.70	0	0
	ZEKI-012-S-2001	2001	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.66	0.214	7.363	1.740	AD	93.04	3.50	4.14	3.82	0	0
	ZEKI-012-S-2002	2002	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.81	0.096	8.735	4.136	NONE	93.04	4.50	4.14	4.32	0	0
	ZEKI-012-S-2003	2003	UT ZEKIAH SWAMP RUN	1	COASTAL-W	6.44	0.107	10.233	2.149	AD	93.04	2.00	2.71	2.36	0	0
BA-P-234-109-95	JONE-109-S-1995	1995	DIPPING POND RUN	1	EPIEDMNT	6.77	2.510	2.090	1.000	NONE	74.33		3.67	3.67	1	0
	JONE-109-S-2000	2000	DIPPING POND RUN	1	EPIEDMNT	6.41	2.386	2.660	0.792	NONE	76.78		4.11	4.11	0	0
	JONE-109-S-2001	2001	DIPPING POND RUN	1	EPIEDMNT	6.67	2.921	1.138	1.091	NONE	76.78		4.11	4.11	0	0
	JONE-109-S-2002	2002	DIPPING POND RUN	1	EPIEDMNT	6.41	3.169	1.246	0.946	NONE	76.78		3.89	3.89	0	0
	JONE-109-S-2003	2003	DIPPING POND RUN	1	EPIEDMNT	6.34	2.649	3.818	1.002	NONE	76.78		4.11	4.11	0	0
BA-P-077-315-96	JONE-315-S-1996	1996	NORTH BR JONES FALLS	3	EPIEDMNT	7.60	1.320	7.360	2.600	NONE	56.62	3.00	3.67	3.34	0	0
	JONE-315-S-2000	2000	NORTH BR JONES FALLS	3	EPIEDMNT	7.52	1.066	6.174	2.007	NONE	56.29	3.22	4.33	3.78	0	0
	JONE-315-S-2001	2001	NORTH BR JONES FALLS	3	EPIEDMNT	8.20	1.522	4.298	1.134	NONE	55.31	3.44	3.00	3.22	0	0
	JONE-315-S-2002	2002	NORTH BR JONES FALLS	3	EPIEDMNT	8.05	0.960	5.600	1.775	NONE	55.31	3.44	3.44	3.44	0	0
	JONE-315-S-2003	2003	NORTH BR JONES FALLS	3	EPIEDMNT	7.50	1.167	7.766	2.240	NONE	56.29	2.78	2.78	2.78	0	0
BA-P-025-102-96	LOCH-102-S-1996	1996	BEAVERDAM RUN	1	EPIEDMNT	6.37	1.530	4.810	4.900	AD	56.69	3.44	3.22	3.33	1	0
	LOCH-102-S-2000	2000	BEAVERDAM RUN	1	EPIEDMNT	6.32	2.326	2.360	1.779	AD	56.60	3.00	4.33	4.33	1	0
BA-P-015-120-96	LOCH-120-S-1996	1996	BAISMANS RUN	1	EPIEDMNT	6.97	2.550	3.990	1.100	AD	58.59	1.89	4.33	4.33	1	0
	LOCH-120-S-2000	2000	BAISMANS RUN	1	EPIEDMNT	7.01	1.075	4.918	0.988	AD	62.99	2.78	3.22	3.22	1	0
	LOCH-120-S-2001	2001	BAISMANS RUN	1	EPIEDMNT	7.14	1.658	2.888	0.790	AD	59.81	2.56	4.33	4.33	1	0
	LOCH-120-S-2002	2002	BAISMANS RUN	1	EPIEDMNT	7.32	1.594	2.204	1.129	NONE	59.81	2.78	3.67	3.67	1	0
	LOCH-120-S-2003	2003	BAISMAN RUN	1	EPIEDMNT	7.01	1.655	6.464	1.024	AD	62.99	2.56	2.56	2.56	1	0
BA-P-057-209-96	LOCH-209-S-1996	1996	GREENE BRANCH	2	EPIEDMNT	7.43	2.300	9.720	1.400	NONE	56.58	2.78	3.44	3.11	0	0
	LOCH-209-S-2000	2000	GREENE BRANCH	2	EPIEDMNT	7.54	1.745	10.518	1.229	NONE	53.91	3.22	3.67	3.45	0	0
HO-P-228-119-97	RKGR-119-S-1997	1997	UN TRIB TO PATUXENT R	1	EPIEDMNT	7.69	1.360	7.170	1.500	NONE	65.92	3.44	4.11	3.78	0	0
	RKGR-119-S-2000	2000	UN TRIB TO PATUXENT R	1	EPIEDMNT	7.49	1.205	7.586	1.564	NONE	66.76	3.89	3.44	3.67	0	0
	RKGR-119-S-2001	2001	UN TRIB TO PATUXENT R	1	EPIEDMNT	6.81	1.648	5.922	1.077	NONE	65.20	3.44	4.11	3.78	0	0
	RKGR-119-S-2002	2002	UN TRIB TO PATUXENT R	1	EPIEDMNT	7.88	1.599	5.783	1.403	NONE	65.20	3.22	3.67	3.44	0	0
	RKGR-119-S-2003	2003	UN TRIB TO PATUXENT R	1	EPIEDMNT	7.56	1.456	7.678	1.344	NONE	65.20	3.00	3.44	3.22	0	0
	FURN-101-C-2000	2000	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.66	0.509	4.055	2.224	AD	86.36	3.89	4.56	4.23	0	0
	FURN-101-S-2001	2001	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.78	0.622	4.882	3.074	AD	86.46	3.89	4.11	4.00	0	0
	FURN-101-S-2002	2002	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.91	0.656	4.620	2.494	AD	86.46	4.11	4.33	4.22	0	0
	FURN-101-S-2003	2003	WINCH RUN (BUCK SWAMP CREEK)	1	EPIEDMNT	6.65	0.516	5.612	3.261	AD	86.46	3.00	3.44	3.22	0	0
	LIBE-102-C-2000	2000	TIMBER RUN	1	EPIEDMNT	6.97	1.126	4.826	0.935	NONE	76.96	4.33	4.11	4.22	1	0
	LIBE-102-S-2001	2001	TIMBER RUN	1	EPIEDMNT	7.14	1.272	4.273	1.140	NONE	74.67	3.22	3.44	3.33	1	0
	LIBE-102-S-2002	2002	TIMBER RUN	1	EPIEDMNT	7.01	1.210	4.272	1.210	NONE	74.67	3.22	4.33	3.78	1	0
	LIBE-102-S-2003	2003	TIMBER RUN	1	EPIEDMNT	6.55	1.265	6.241	2.389	AD	74.67	2.78	3.67	3.67	1	0
AL-A-207-307-95	FIMI-207-S-1995	1995	FIFTEENMILE CREEK	3	HIGHLAND	6.91	0.260	10.340	2.000	AD	89.73	2.71	4.11	3.41	0	0
	FIMI-207-S-2000	2000	FIFTEENMILE CREEK	3	HIGHLAND	7.09	0.196	9.015	2.211	AD	89.69	3.29	3.44	3.37	0	0
	FIMI-207-S-2001	2001	FIFTEENMILE CREEK	3	HIGHLAND	7.10	0.402	8.793	0.898	AD	89.51	3.57	3.44	3.51	0	0
	FIMI-207-S-2002	2002	FIFTEENMILE CREEK	3	HIGHLAND	7.28	0.256	11.778	1.494	NONE	89.51	3.86	3.22	3.54	0	0
	FIMI-207-S-2003	2003	FIFTEENMILE CREEK	3	HIGHLAND	7.14	0.301	9.512	1.197	AD	89.69	4.43	3.89	4.16	0	0
AL-A-626-216-96	PRLN-626-S-1996	1996	MILL RUN	2	HIGHLAND	7.51	0.680	12.890	1.100	NONE	100.60	2.71	3.67	3.67	1	0
	PRLN-626-S-2000	2000	MILL RUN	2	HIGHLAND	7.56	0.443	13.174	0.987	NONE	100.00	3.57	4.56	4.07	1	0
	PRLN-626-S-2001	2001	MILL RUN	2	HIGHLAND	7.67	0.841	12.188	0.879	NONE	100.00	3.86	4.11	3.98	1	0
	PRLN-626-S-2002	2002	MILL RUN	2	HIGHLAND	7.16	1.888	13.214	1.618	NONE	100.00	2.43	4.56	4.56	1	0
	PRLN-626-S-2003	2003	MILL RUN	2	HIGHLAND	7.59	1.141	13.293	1.078	NONE	100.00	2.43	4.33	4.33	1	0
GA-A-159-202-96	SAVA-159-S-1996	1996	MIDDLE FORK RUN	2	HIGHLAND	6.83	0.720	14.050	1.000	AD	90.35	4.14	3.44	3.79	1	0
	SAVA-159-S-2000	2000	MIDDLE FORK RUN	2	HIGHLAND	7.03	0.425	13.162	0.789	AD	90.21	4.43	4.33	4.38	1	0
	SAVA-159-S-2001	2001	MIDDLE FORK RUN	2	HIGHLAND	7.12	0.774	12.592	0.548	AD	90.15	4.14	4.33	4.24	1	0
	SAVA-204-C-2001	2001	CRABTREE CR	2	HIGHLAND	7.37	0.707	12.914	0.579	NONE	89.30	3.86	4.33	4.10	1	0
	SAVA-204-S-2002	2002	CRABTREE CR	2	HIGHLAND	6.93	0.791	14.104	0.886	AD	89.30	2.71	3.67	3.67	1	0
	SAVA-204-S-2003	2003	CRABTREE CR	2	HIGHLAND	7.66	0.519	14.270	0.711	NONE	89.30	3.29	4.11	3.70	1	0
GA-A-999-302-96	SAVA-225-S-1996	1996	SAVAGE RIVER	3	HIGHLAND	7.07	0.800	12.030	1.500	AD	83.46	4.14	4.33	4.24	1	0
	SAVA-225-S-2000	2000	SAVAGE RIVER	3	HIGHLAND	7.26	0.452	11.607	2.449	AD	83.87	3.57	4.78	4.18	1	0
	SAVA-225-S-2001	2001	SAVAGE RIVER	3	HIGHLAND	7.22	0.917	10.399	1.173	AD	83.84	4.14	3.67	3.90	1	0
	SAVA-225-S-2002	2002	SAVAGE RIVER	3	HIGHLAND	7.21	0.871	12.284	2.572	AD	83.84	2.71	4.33	4.33	1	0
	SAVA-225-S-2003	2003	SAVAGE RIVER	3	HIGHLAND	7.11	0.995	11.522	1.901	AD	83.84	3.00	4.78	3.89	1	0

Table Appendix D9

SITE (95-97)	SITENEW	SAMPLED	STREAM NAME	ORDER	STRATA_R	PH_LAB	NO3_LAB	SO4_LAB	DOC_LAB	ACID SOURCE	PERCENT FOREST	FIBI	BIBI	CBI	BRKTROUT	BLACKWAT
GA-A-276-106-96	SAVA-276-S-1996	1996	DOUBLE LICK RUN	1	HIGHLAND	6.77	0.490	12.890	0.800	AD	92.12	4.71	3.67	4.19	1	0
	SAVA-276-S-2000	2000	DOUBLE LICK RUN	1	HIGHLAND	6.75	0.329	12.110	0.700	AD	92.64	4.14	4.33	4.24	1	0
	SAVA-276-S-2001	2001	DOUBLE LICK RUN	1	HIGHLAND	6.76	0.542	10.703	0.284	AD	91.01	4.14	3.89	4.02	1	0
	SAVA-276-S-2002	2002	DOUBLE LICK RUN	1	HIGHLAND	6.46	0.570	11.630	0.547	AD	91.01	3.29	4.56	3.92	1	0
	SAVA-276-S-2003	2003	DOUBLE LICK RUN	1	HIGHLAND	6.70	0.557	11.309	0.352	AD	91.01	3.29	4.11	3.70	1	0
FR-P-288-133-96	UMON-288-S-1996	1996	TRIB TO HUNTING CREEK	1	HIGHLAND	7.33	0.560	6.490	1.700	NONE	88.62	4.14	3.22	3.68	0	0
	UMON-288-S-2000	2000	TRIB TO HUNTING CREEK	1	HIGHLAND	6.52	0.163	3.653	1.603	AD	81.63	2.43	4.33	4.33	1	0
	UMON-288-S-2001	2001	TRIB TO HUNTING CREEK	1	HIGHLAND	6.52	0.396	3.656	0.678	AD	87.89	2.43	4.33	4.33	1	0
	UMON-288-S-2002	2002	TRIB TO HUNTING CREEK	1	HIGHLAND	6.87	0.227	3.190	1.156	AD	87.89	2.43	4.33	3.38	0	0
	UMON-288-S-2003	2003	TRIB TO HUNTING CREEK	1	HIGHLAND	6.54	0.321	4.622	1.378	AD	87.89	2.43	5.00	5.00	1	0
	UMON-119-S-2002	2002	BUZZARD BRANCH	1	HIGHLAND	7.46	0.189	8.352	2.740	NONE	99.33	2.43	4.56	4.56	1	0
	UMON-119-S-2003	2003	BUZZARD BRANCH	1	HIGHLAND	7.25	0.387	7.125	2.318	NONE	99.33	2.14	4.78	4.78	1	0
GA-A-432-315-95	YOUG-432-S-1995	1995	BEAR CREEK	3	HIGHLAND	6.96	0.650	9.590	1.000	AD	76.12	4.14	4.11	4.13	1	0
	YOUG-432-S-2000	2000	BEAR CREEK	3	HIGHLAND	7.01	0.788	9.773	2.329	AD	76.25	3.86	4.78	4.32	1	0
	YOUG-432-S-2001	2001	BEAR CREEK	3	HIGHLAND	6.47	1.023	8.589	0.956	AD	76.35	4.14	4.56	4.35	1	0
	YOUG-432-S-2002	2002	BEAR CREEK	3	HIGHLAND	7.11	1.234	9.605	1.439	AD	76.35	4.14	3.89	4.02	1	0
	YOUG-432-S-2003	2003	BEAR CREEK	3	HIGHLAND	7.10	0.738	8.373	0.799	AD	76.35	3.86	3.67	3.76	1	0

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